Power and The Engineer

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IT IS an undisputed fact that boilers explode for want of sufficient strength to withstand the pressures carried.

The trouble may be due to faulty design or poor workmanship in the original construction, though more frequently the weakening is due to unequal expansion and contraction, to corrosion or to improper repairs.

Should any part of a boiler become sufficiently weakened and rupture occur, the steam pressure will be suddenly reduced and release the energy stored up in the water. The large volume of water, thus relieved of pressure, will instantly flash into steam, the sudden shock causing a further opening of the rent and producing destructive results.

The fracture will not always follow the path of structural weakness, for new forces are set up when the above shock occurs and it is almost impossible to predict the line of failure.

It is estimated that a cubic foot of water under 70 pounds pressure and heated to a temperature corresponding to steam at that pressure, contains about the same energy as one pound of gunpowder. Further, that a plain cylindrical boiler of average size with steam at 100 pounds pressure and filled with water to the proper level, has sufficient stored energy to project the boiler to a height of 3½ miles.

It is thus seen that the extent of an explosion depends not so much upon the amount of steam contained in the boiler as to the amount of hot water ready to flash into steam.

In this fact lies the greater safety of the water-tube boiler over that of the fire tube.

All boilers if not properly cared for are liable to explode.

Due to the effects of unequal expansion and contraction and perhaps causes beyond the control of the engineer, the plates are liable to become weakened to such an extent that the affected portion has to be removed and a patch substituted.

Here is where special care and skill should be employed.

For more boiler explosions have been caused by improperly applied repairs than from defects in original design.

An engineer owes it to the public, and to himself, to thoroughly understand the operation of his boiler and how to properly make repairs.

While boilermakers should always be employed to make the repairs, the engineer should be in a position to judge the quality of their work; for after all, he is the one to whom all responsibility is attached

Read the article in this issue on patching boilers. It will be time well spent.

Raising Water by Its Own Energy

By Simpson Rice

New plant recently installed by the Hanford Irrigation and Power Company at Priests rapids, Wash., will eventually have capacity of 2600 horsepower. One 1300-horsepower hydraulic turbine of vertical triplex type is now installed to operate under normal head of 18 feet and at a speed of 150 revolutions per minute. This plant will furnish current to pumping station 16 miles down the river, equipped with two 450-horsepower induction motors driving single-stage centrifugal pumps, capable of delivering 62½ cubic feet of water per second against a total head of 50 feet for irrigation purposes.

The principal consideration affecting the design of the new power station of the Hanford Irrigation and Power Company at Priests rapids, Wash., was that of the extreme variation between low-water and flood level, the minimum head being 18 feet and the maximum 27 feet. In order to place the generator and electrical apparatus above the highest flood water, vertical triplex units were adopted. By choosing a triplex turbine, sufficient speed was obtained for direct connection to the generators.

The voltage generated in the main power station is stepped up by transformers and the power is transmitted 16 miles to a pumping station down the river, where induction-motor-driven single-stage centrifugal pumps deliver the water from the river up into the irrigating ditches. This pumping station is built for four pumping units, two of which are now installed and in operation. The total power at Priests rapids will permit of the installation of several other pumping substations at some future time, located as required by the demand for irrigating water.

The inception and successful development of this project is an important event both from an engineering and economic standpoint, illustrating as it does the entire feasibility of reclaiming for cultivation, lands heretofore undeveloped on account of lack of water, available for irrigation by a gravity system.

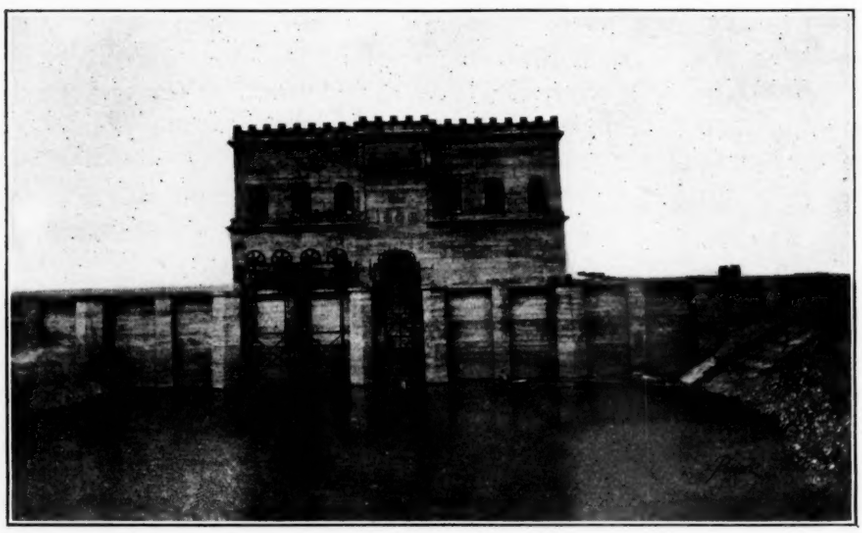


FIG. 1. POWER HOUSE FROM CANAL SIDE

The power station is located near the town of Kennewick, Wash., on the Columbia river, about 20 miles from the Oregon State line. The river, in this section, flows in a southeasterly direction for some miles and then makes a wide sweep to the south and west, which direction it follows till it reaches the Pacific ocean. At the point where the Hanford company's plant is located, the river forms what are known as Priests rapids. By means of a dam, reservoir and canal, protected from the river by a retaining wall and embankment, provision was made for an ultimate development of 9800 horsepower from a minimum head of 18 feet. The present power station is designed for a normal capacity of 2600 horsepower with one unit of 1300 horsepower already installed.

GENERAL LAYOUT

The dam was built across the southern channel of the river, through which at low water there is a flow of about 12,000 cubic feet per second. A short distance above the dam, an intake 140 feet wide and 700 feet long connects the river with a natural lagoon and uses part of the water backed up by the dam. This lagoon is from 1 to 7 feet deep at low water and three-quarters of a mile long. At its eastern end, a canal 67 feet wide and about a mile in length carries the water to the power-house intake. Gates were installed at the junction of the lagoon and the canal to regulate the supply of water and a retaining wall and embankment were built from the dam along the lagoon and the canal to afford protection from the river.

The canal head gates are made up of ten gates of the butterfly type and one pad gate. Each of the butterfly gates is 18 feet long with a vertical depth of seven feet, measured from the canal bottom. The gates swing on a horizontal shaft and are operated by means of continuous cables attached to a windlass.

POWER HOUSE

The power house is of reinforced concrete, resting on bed rock and is about 67 feet square at the foundation. Owing to the extreme fluctuations of the level of the river, it was necessary to place the generator floor 58 feet above the lower draft floor. Fig. 1 shows an exterior view taken from the canal side. An idea of the general design and construction may be had from the plan and sectional view, Figs. 2 and 3.

HYDRAULIC APPARATUS

The main turbine unit is of the vertical triplex type, designed to run at 150 revolutions per minute under a normal head of 18 feet with a total variation in head from 16 to 27 feet. The arrangement, as shown in Fig. 3, consists of a twin center-discharge turbine mounted on the same shaft above a single turbine. The twin turbine runners discharge into a cast-iron center-discharge casing which is rigidly connected by column construction to the lower single turbine. The runners are of cast iron and each develops 333⅓ brake horsepower or a total of 1000 brake horsepower under the conditions mentioned.

The characteristics of these runners enable normal speed to be maintained under a reduction of normal head with but slight loss in efficiency, thus making them particularly desirable for variable head propositions. The following effi-

ciencies were guaranteed under normal operating conditions: Full gate, 80 per cent.; three-quarter gate, 82 per cent.; one-half gate, 78 per cent.

The turbine gates are of the swivel type, operated through governor shafts. This type of gate, sometimes known as the "wicket type," is considered far more efficient than any other type. Its advantages over the ordinary cylinder types are as follows: Swivel gates give good efficiency with both small and large gate openings, while the efficiency of cylinder gates is low, except in wide open positions, due to excessive hydraulic disturbances, eddies, etc. With the use of swivel gates, the increase or decrease in power resulting from opening or closing the gates occurs uniformly throughout the stroke, from wide open to closed positions, which characteristic is necessary for uniformly sensitive regulation from no load to full load. With the cylinder type, a considerable closing of the gates from wide open position is necessary before any reduction in power is effected. Moreover, at very small gate openings (required for friction load) the friction eddies of the water are so great passing through the gates that no power whatever is developed in the wheel. This, of course, results in poor regulation at full gate and friction-load openings. The governor supplied with the main unit is of the standard Allis-Chalmers oil-pressure type and is shown in Fig. 4. This governor operates with great quickness and holds the speed variation, due to ordinary load fluctuations, within the most narrow limits; yet it is safe from hunting or overtravel even under the most difficult operating conditions.

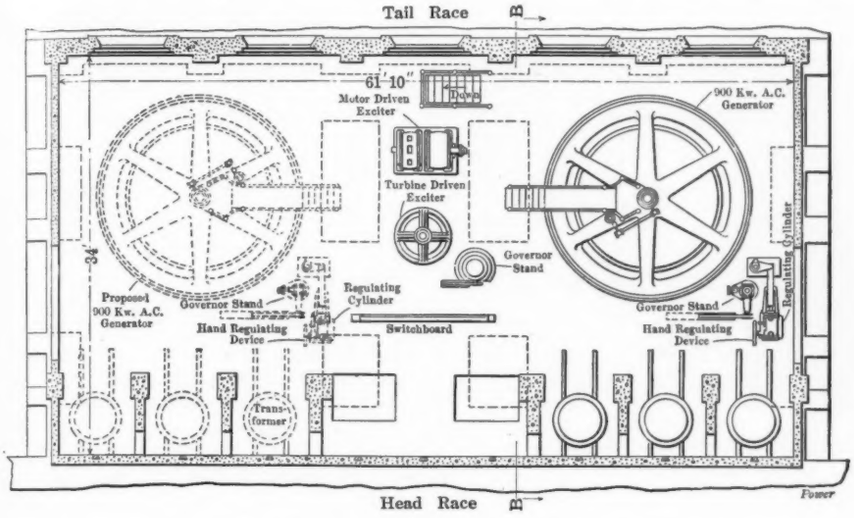


FIG. 2. PLAN OF GENERATOR FLOOR

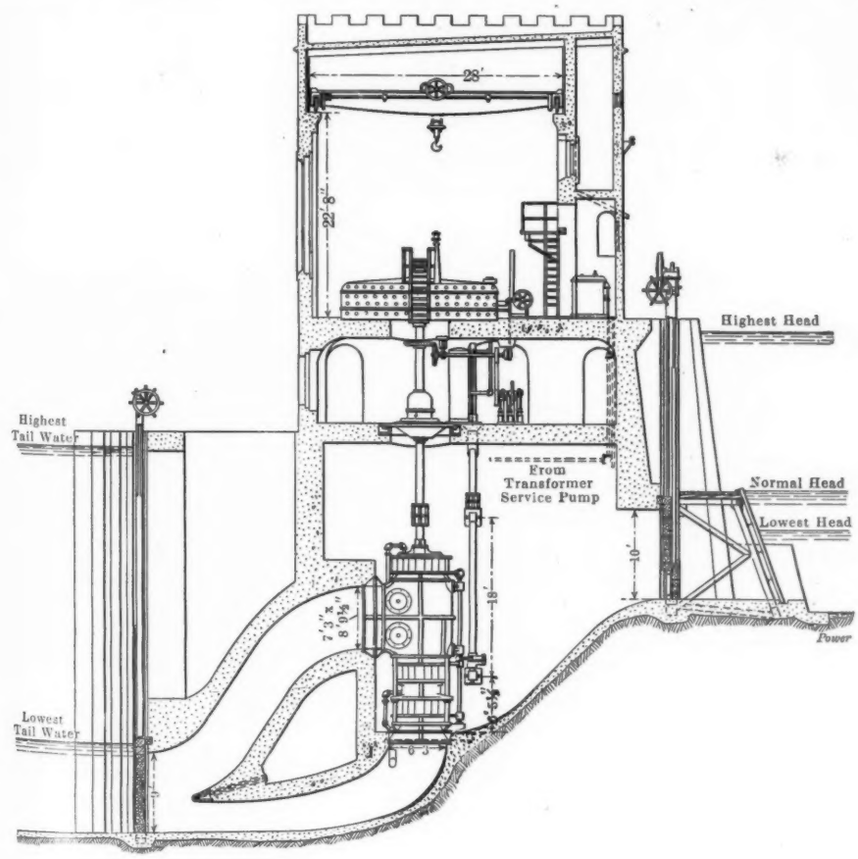


FIG. 3. TRANSVERSE SECTION B-B OF POWER HOUSE

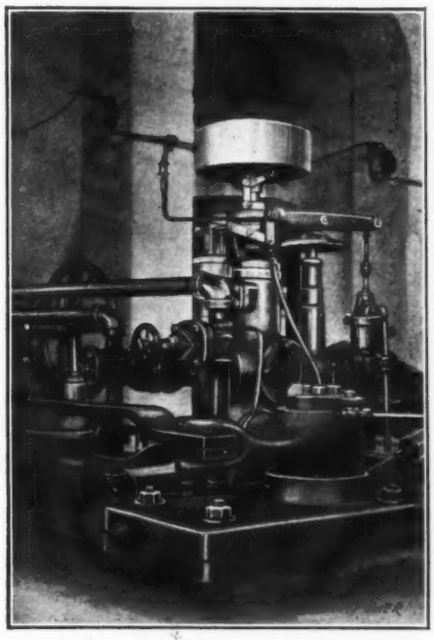


FIG. 4. TURBINE GOVERNOR

The thrust bearings furnished with both generator and exciter turbines are of the standard oil-bath self-contained type and are located on the intermediate trust-bearing floor.

Three babbitt-lined steady bearings are supplied for the turbine shaft; one above the lower turbine, another just above the top turbine and the third underneath the thrust bearing. This last bearing is supported by the bulkhead carrying the thrust bearing.

The concrete draft tubes are designed to lead the water from the center-discharge casing and lower runner with uniformly decreasing velocity and minimum hydraulic disturbance to the tail race, thus abstracting the maximum practicable amount of kinetic energy.

A vertical, single-runner, open-flume, direct-connected exciter turbine designed for 225 revolutions per minute and 100 brake horsepower at 21-foot head is part of the installation. The runner is of iron, cast in one solid piece. The swivel gates, steady bearing, thrust bearing and governor are similar in design to those for the main unit.

The flume head gates are so constructed as to insure maximum reliability and ease of operation. The main turbine gate is double and each gate is made in two parts constructed of 9x9¼-inch timbers. The hoisting gear is attached to the lower outside section and thus obviates the necessity of a large and heavy hoisting device. When the gates are opened, the lower leaf is raised just to the point where the angle iron near the bottom engages the lower edge of the upper leaf; see Fig. 3. The water is thus bypassed under the gate, relieving the pressure so that both sections can be easily raised to the wide open position. The gates move in steel guides and are provided with iron slides which offer less friction and prevent wearing.

Each gate has two racks which are operated by a handwheel and shaft, on which are two worm gears which engage with gears and pinions meshing with the racks. The top timber of the lower section and bottom timber of the upper section are cut at an angle as shown, to make a water-tight joint at the upper edge of the gates.

The exciter unit is also supplied with a head gate, constructed of heavy timbers reinforced with angle irons, and sliding in a steel frame. The hoisting device consists of a worm gear operating the rack pinion through gearing by means of a handwheel and shaft.

Discharge gates are supplied with the generator and exciter turbines. The gate for the main unit is made in two separate sections, controlled by separate hoisting devices, and is constructed of 10½x10½-inch timbers rigidly reinforced with angle irons and sliding in steel frames. The hoisting rigs and racks are of the same general design as those used for the head gates. The discharge gate for the exciter unit is of similar construction. These discharge gates make it possible to pump out the turbine flumes for inspection when so desired.

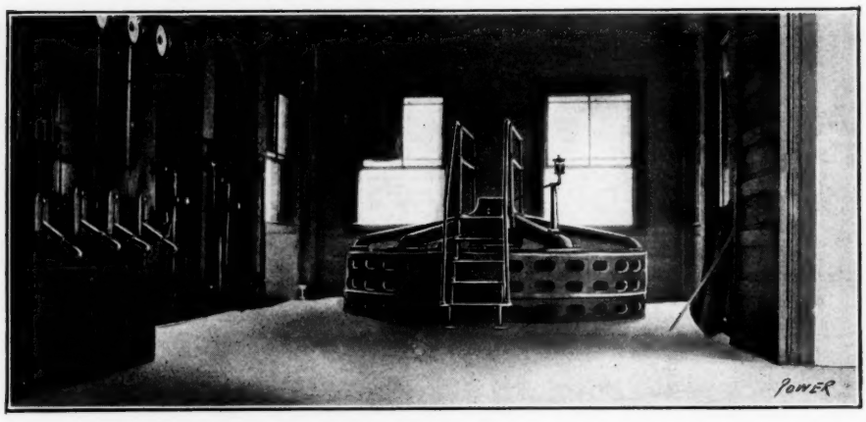


FIG. 5. INDUCTION MOTOR IN PUMPING STATION

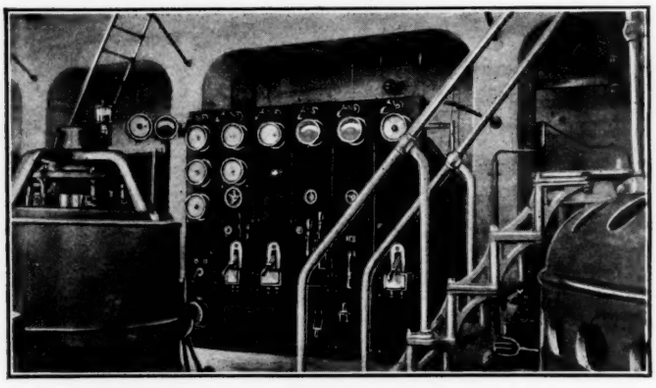


FIG. 6. SWITCHBOARD IN POWER HOUSE

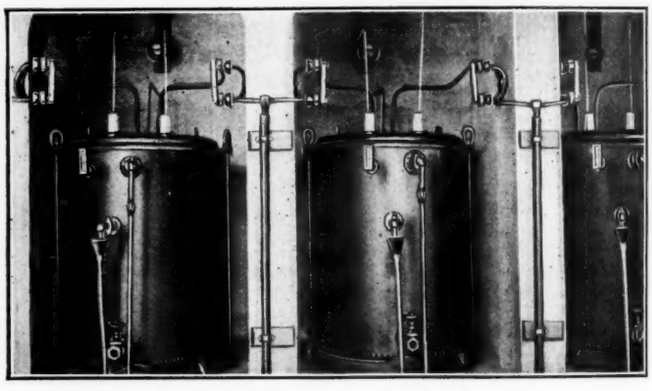


FIG. 7. 22,000-2200-VOLT TRANSFORMERS

ELECTRICAL APPARATUS

The electrical power is supplied by one 900-kilowatt, three-phase, 60-cycle, revolving-field generator direct connected to the turbine and running at 150 revolutions per minute.

The stator yoke of the generator is of cast iron, with a special cast-iron base, in which the laminated steel armature core is rigidly mounted. A spider shown in Fig. 5 is bolted to the top of the stator, and carries the upper steady bearings and field collector rings.

The rotor is of the "umbrella" construction especially designed to withstand the stresses due to its large diameter and horizontal position. It is mounted on a short shaft coupled to the turbine shaft above the thrust bearing.

The exciter generator is a 60-kilowatt, 120-volt, 500-ampere, direct-current machine running at 225 revolutions per minute and direct connected to the single vertical turbine previously described. This generator is compound wound so as to

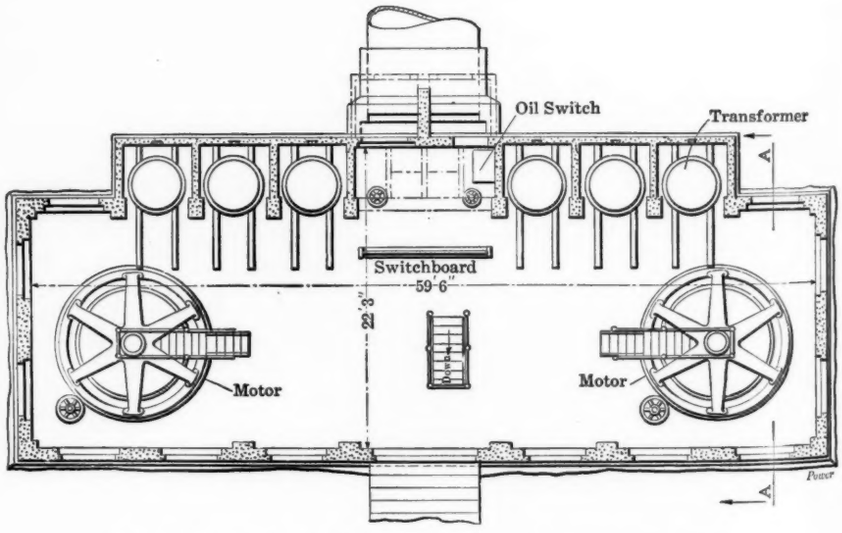


FIG. 8. MOTOR AND TRANSFORMER ROOM IN PUMPING STATION

maintain the voltage constant at 120 volts from no load to full load, and is capable of carrying momentary overloads of 75 per cent. without flashing or serious sparking.

A 60-kilowatt, 120-volt, 500-ampere, direct-current generator is direct connected to a three-phase, 60-cycle, 2200-volt, 85-horsepower induction motor. This unit is located on the generator floor of the station and may be used in place of the turbine-driven exciter if so desired. The adoption of this set instead of a second turbine-driven exciter resulted in a considerable saving of space.

The switchboard shown in Fig. 6, consists of six panels: One generator panel, two exciter panels, one induction-motor panel, one transformer panel and one outgoing-line panel. All instruments and apparatus necessary are provided for each panel, including oil switches and remote control for the 22,000-volt line.

Three 400-kilovolt-ampere, oil-filled, water-cooled, 2200- to 22,000-volt transformers are provided for stepping up the voltage for the tranmission line to the pumping station. The transformers are located back of the switchboard in compartments separated by concrete partitions as shown in Fig. 7. Space is allowed for three more transformers of the same capacity, which will be installed when the second generating unit is put in. These transformers are capable of carrying a 50 per cent. overload continuously for 20 minutes without injury and can safely carry 25 per cent. overload for two hours.

The 2200-volt oil switches mentioned are located on the intermediate, or thrust-bearing floor, together with the low-tension 2200-volt busbars. All of the low-tension wiring is concealed and is carried in fiber conduits.

Transmission Line

The pole line connecting the power house to the pumping station is 16 miles long. The poles are of cedar, 40 feet in hight, spaced 142 feet apart, and guyed with galvanized wire wherever necessary.

The three-phase current at 22,000 volts is carried over No. 4 Brown & Sharpe, hard-drawn copper wires placed 54 inches apart in the form of an isosceles triangle. The line is transposed once every mile for the benefit of the telephone wires connecting the power house and pumping station, which are carried on the same poles. The telephone wires are transposed every ten poles.

Pumping Station

The design and arrangement of the pumping station is shown in Figs. 8 and 9. It is built along the same general lines as the power station, both the substructure and superstructure being of reinforced concrete. The foundations rest on bed rock and are built high enough to place the main motor floor above the highest flood level of the river. The station is 25 feet wide by about 32 feet long and is built with provision for two more pumping units of the same general design as those now installed but with a higher head capacity.

The intake tunnel is built of concrete and extends about 300 feet out into the river to a point where the intake crib is below the lowest water level of the river. The tunnel is 5 feet in hight and of varying cross-section.

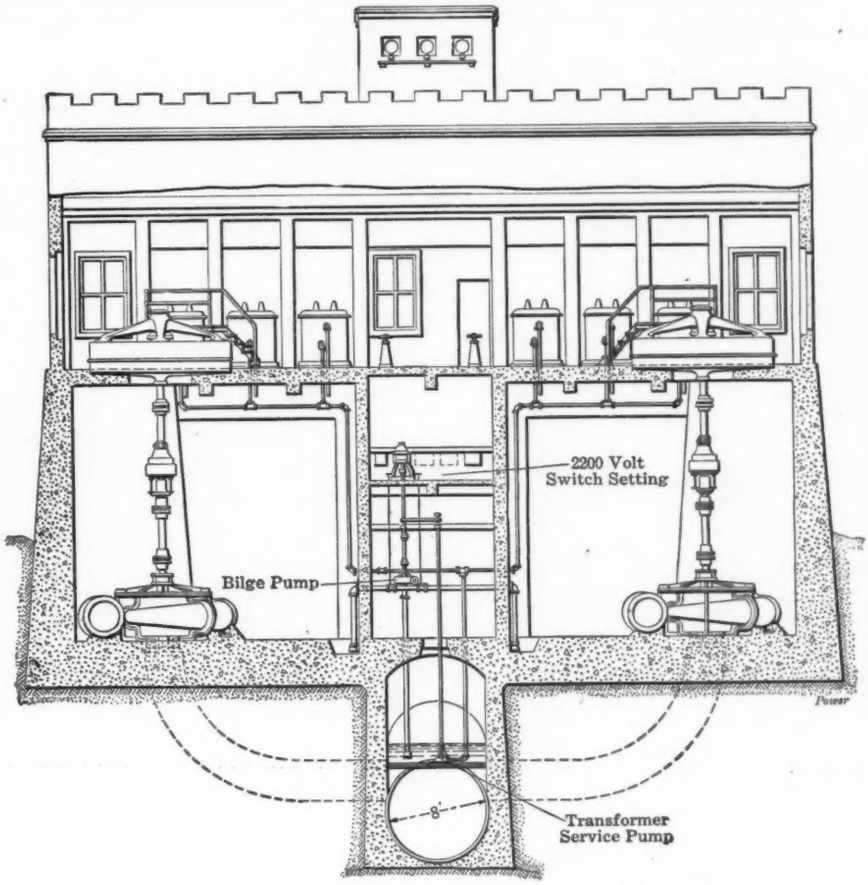


Fig. 9. Longitudinal Section of Pumping Station

Pump-house Electrical Apparatus

The main centrifugal pumps are driven by two 450-horsepower, three-phase, 60-cycle, induction motors running at 175 revolutions per minute and wound for 2200 volts. The rotors are of the "squirrel-cage" type, and are provided with polyphase windings adapted to the insertion of resistance for starting under load or for speed regulation.

The switchboard is of black enameled slate mounted upon a steel frame, and consists of two motor panels, one line panel, one lighting panel and one transformer panel. The oil switch operating the 22,000-volt line is similar to that installed in the main power station, as are also the mechanically operated, remote-control, 2200-volt, oil switches, choke coils, etc.

There are three 400-kilovolt-ampere, 60-cycle, three-phase, 22,000- to 2200-volt transformers installed in the pumping station of the same design as those in the power house.

The switchboard and transformers are located on the upper floor with the main pump motors. The high-tension, 22,000-volt busbars are supported by insulators on the wall back of the switchboard and the 22,000-volt oil switches are also carried on brackets fastened to the center concrete partition. Lightning arresters are inserted in the high-tension line before connecting to the oil switches.

Hydraulic Apparatus in Pumping Station

The two centrifugal pumps are of the single-stage, vertical, direct-connected type, designed to deliver 62½ cubic feet of water per second against a total head of 50 feet. Self-alining thrust bearings, carrying the weight of the revolving parts, are supported on I-beams above the pump casings. An efficiency of 65 per cent. is guaranteed for the operation of these pumps.

Thirty-inch sluice gates are placed at the suction inlet of each pump with an operating valve stem extended up to floor stands and handwheels on the intermediate floor. Thirty-inch discharge valves are bolted to the discharge casings of the pump with the valve stems also extended up to the intermediate floor.

A vertical-shaft, motor-driven, centrifugal bilge pump (see Fig. 9) similar to that in the power house, is located over the intake tunnel on the basement floor and is used both for emptying the intake tunnel and for priming the main pumps. A small pump of similar design and driven by a belt from the bilge-pump shaft furnishes cooling water for the transformers.

The installation of the hydraulic and electrical apparatus in the power house and pumping station is worthy of special notice in view of the rapidity with which the work was done and the lack of interruption in the service after the units were first put into commercial operation.

As the two stations are located about 80 miles from the nearest railroad and 125 miles from a machine shop, it was necessary for the construction force to rely wholly upon the tools they could carry with them, for installing the apparatus and repairing any damage incurred in transportation.

The apparatus was transferred from the cars to a steamboat at Kennewick, and carried up the Columbia river to a point as near to the work as could be reached and was then hauled by mule teams to the pumping station and power plant over roads which are none too good at the best.

Applying Patches to Boilers

By H. S. Jeffery

When scale or oil is allowed to accumulate in a boiler and become baked, it not only lessens the transmission of heat through the plates, but also often causes them to become overheated and bulge or crack. These defects are often of such a serious nature as to require the removal of the affected section and the substitution of a patch. The most approved methods of applying these patches are presented by the author.

A boiler is patched because a certain part has deteriorated to the extent that economy in the generation of steam is impossible, or to such an extent that the boiler cannot be safely operated. If a return-tubular boiler is allowed to become full of loose mud or scale, or if oil, grease, etc., are allowed to get into the boiler, the shell will sooner or later bulge, as shown in Fig. 1.

Such deformation of the plate is a sign that it has been overheated, the internal pressure having forced it from its natural position. If permitted it will continue to thus force it until the plate is stretched to the point of rupture, though a boiler explosion does not necessarily follow. The overheating is due to foreign substances (contained to a greater or less degree in nearly all waters) adhering to the shell or other heating surface and hindering the generation of steam.

As long as the plate on one side is directly in contact with the water, it will never become overheated. But when foreign substances attach themselves to the sheet, it is then only indirectly cooled by the water, and the thicker the scale, the easier for overheating to take place. Though the temperature of the fire may

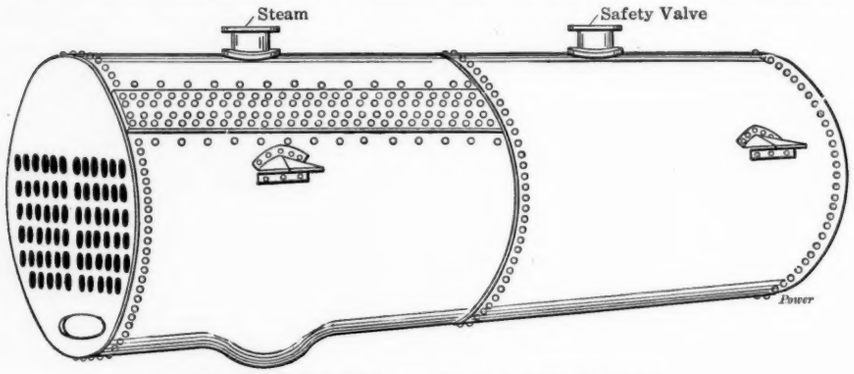


FIG. 1. BULGED PLATE, DUE TO OVERHEATING

be as high as 2000 degrees, the plate, if clean and directly in contact with the water, will not bulge, unless it be improperly designed.

The area of the plate suffering from deformation may be large or small, with a tendency to grow if prompt action is not taken to remove the foreign substances. If these foreign substances are removed in time and the deformation is small, the plate may be set back to its original form. To accomplish this it should be heated with some form of portable furnace and, while hot, forced back into place by the aid of sledges or jacks. Care should be taken to work the bulge back gradually, and never drive the center or lowest point first. It is best to nurse the plate back instead of driving it with heavy blows, as the latter method is apt to leave the surface indented with more or less uneven spots.

Should the deformation of the sheet be such as to require the bulge to be cut out, or if a lamination such as shown in Fig. 2 occurs and necessitates the removal of the defective part, then a patch must be resorted to. This, however, is on the assumption that the patch required is of reasonable size. The defective plate should never be cut so as to leave a hole with square corners as *A*, Fig. 3. If it be a small patch, the corners should have a radius of at least 2 inches, although 6 inches is preferable, and the width *B* should be kept to a minimum.

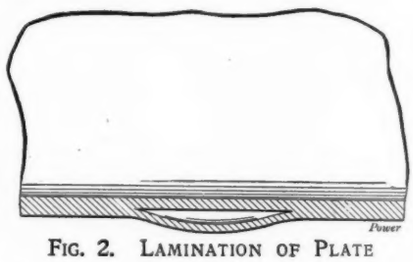


FIG. 2. LAMINATION OF PLATE

A patch as applied to a boiler has a single-riveted lap joint, and if the joint be in the longitudinal plane, its efficiency should be equal to that of the riveted joint of the shell, which governs the allowable working pressure. The boiler may be constructed with a riveted joint of high efficiency—say, an 85 per cent. triple-riveted double-strapped butt joint—yet patched in such a manner that the efficiency will be cut from 85 per cent. to about 50 per cent., carrying with it, of course, a corresponding reduction in allowable pressure. If the width of the patch is considerable—say 24 inches—it is better to cut the hole the shape shown at *C*, Fig. 3. A diagonally riveted joint permits a greater working pressure, as the force acting on it is less than the force acting on a similar joint in the longitudinal plane. It is well to bear in mind that the force acting on the longitudinal plane is twice as great as the force acting on the transverse plane. This briefly explains why a single-riveted lap joint is permissible for the girth seam and not for the longitudinal seam.

INSIDE AND OUTSIDE PATCHES

Although some boilermakers and engineers hold that it is immaterial whether the patch is applied on the outside of the boiler, as shown at *B*, Fig. 4, or on

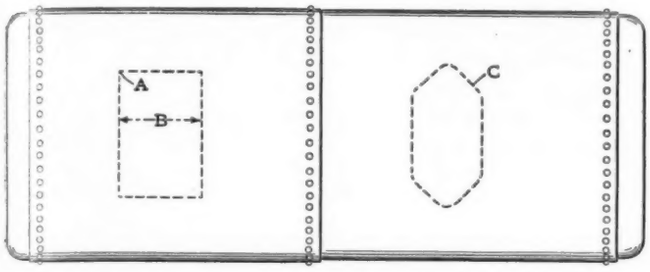


FIG. 3. SHAPE OF HOLES

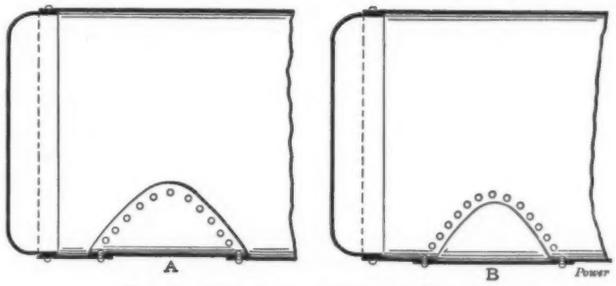


FIG. 4. INSIDE AND OUTSIDE PATCHES

the inside as shown at *A*, the latter is generally accepted to be the better practice, for it affords no recess for the collection of foreign substances as is the case when the patch is applied on the outside.

To apply the patch on the inside, some means must be provided to get the patch within the boiler. Many boilers have no manhole below the tubes, and, moreover, the patch is often too large to pass through the manhole, which according to the generally adopted standard, is not greater than 12 inches in width and 16 inches in length. Hence, when cutting out the defective part of a sheet, it must be seen to that the shape of the hole is such as to readily allow the patch to pass through. This means that the hole cannot be cut round, and in some instances cannot be made square; that is, the length and width cannot be made the same.

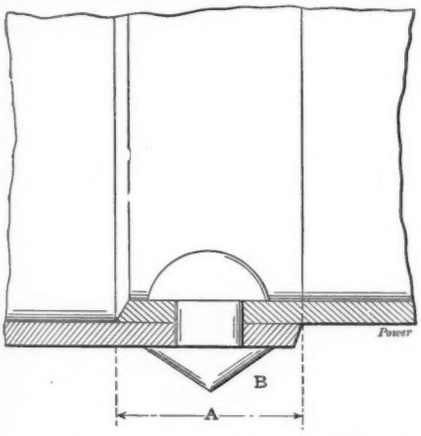


FIG. 5. RIVET WITH CONICAL HEAD

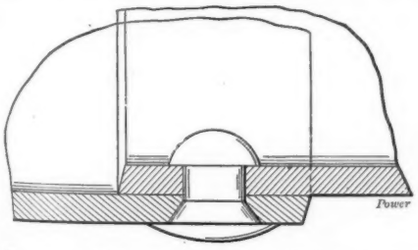


FIG. 6. OVAL RIVET WITH COUNTERSUNK HEAD

The patch should be riveted to the shell; and never applied with patch bolts, unless it is utterly impossible to employ rivets. Should there be a manhole below the tubes, a man can easily enter the boiler and hold on to the rivets, or, as some term the operation, "bucking up the rivets." The patch, however, may be of such a shape as to necessitate the removal of some of the tubes in order to permit the "holder-on" to place the dolly-bar on the rivets. Every tubular boiler, if not fitted with a manhole below the tubes, should at least have a handhole, and through this handhole a holding-on bar with a long handle can be employed to hold the rivets.

A patch so located that the flames and hot gases are constantly in contact with it, is liable to have its seam leak to a greater or less degree, because the high temperature on one side causes the lap that is directly in contact with the flame to become hotter than the other lap that is in contact with the water. Referring to Fig. 5, with the lap *A* not directly in contact with the water, if the distance from the center of the rivet hole to the edge of the plate is made too great the plate will crack from the rivet hole to the edge of the sheet. These are termed "fire cracks" and are caused by strains due to overheating. Sometimes, however, they can be closed by using a calking tool called a fuller.

FIRE CRACKS

It is not advisable to have the rivet heads, which are exposed to the flames, of excessive size. If the rivets are hand driven, as is usually the case when the work is done outside the boiler shop, the holes should be slightly chamfered, and the rivet heads formed as shown at *B*, Fig. 5. Another good method is to countersink the holes and install the rivets with oval heads, as shown in Fig 6.

The main object is to have as little as possible of the rivet head, also the plate, removed from contact with the water. The less the plate is only indirectly cooled by the water, the less will be the trouble with fire cracks and leaky seams. When a patch is applied on the outside of a boiler, it is calked to the shell plate; or if applied on the inside, the shell plate is calked to the patch, little or nothing being gained by calking both the inside and the outside. The calking should be done with a round-nosed fuller; never use white lead, tar paper, etc., between the patch and shell plate.

Fire cracks do not always give trouble. Many engineers, when they find that the shell sheet has cracked from the rivet hole to the edge of the plate, become greatly alarmed, but their fears are hardly well founded. However, should the shell sheet crack the reverse way, that is, into the solid plate, then prompt attention should be given.

Should the plate crack, and calking not stop the leak, the plate may be cut out, as shown in Fig. 7. This is done by merely removing the surplus material, though sufficient material must be left to prevent the plate from crushing or shearing in front of the rivet. It is the practice to cut the plate as shown, only where necessary, which is seldom in more than three or four places.

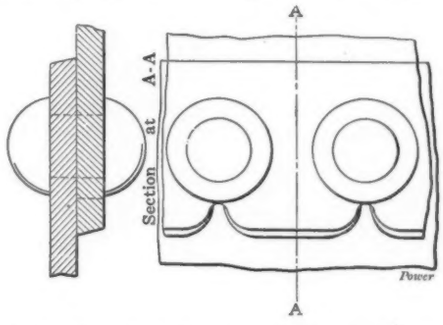


FIG. 7. SURPLUS MATERIAL REMOVED FROM PLATE

Fire cracks may also be repaired by cutting out and renewing the rivets, and countersinking the holes in an eccentric shape, as shown in Fig. 8. In this method the plate is beveled off so as to reduce to a minimum the amount of metal which is only indirectly cooled by the water. Owing to the shape of the countersink, the operation is done by hand with a sharp flat chisel and hammer.

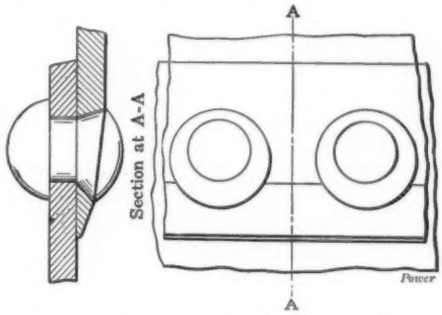


FIG. 8. HOLES COUNTERSUNK ECCENTRICALLY

"Bricks" for the Boiler Inspector

By T. T. Parker

Free advice is usually held in low esteem. Bradley, the boiler inspector, gave some with the result that, although it was followed to good advantage, he nearly lost (?) his job.

Bradley, the boiler inspector, got to the plant of Bildad & Sons at 9 o'clock on the morning of a cold Thanksgiving day to inspect the two 66-inch by 18-foot horizontal, tubular boilers. He had four more to do before 2 o'clock, and he was in a hurry to get finished and reach home. Of course, the boilers were not ready, and old Jenkins, the engineer, nursing a black pipe, was cursing in a weak and vapid way everything in sight, including all boiler inspectors. The fireman, a greenhorn, was a picture of dumbness as he perched on the coal pile awaiting vainly for orders. Bradley slipped into his overalls, grinned pleasantly at the fireman, while Jenkins discoursed on blowoff pipes clogged with scale and cursed with fervor steamfitters, boilermakers and the public in general, and showed no disposition to get the boilers empty.

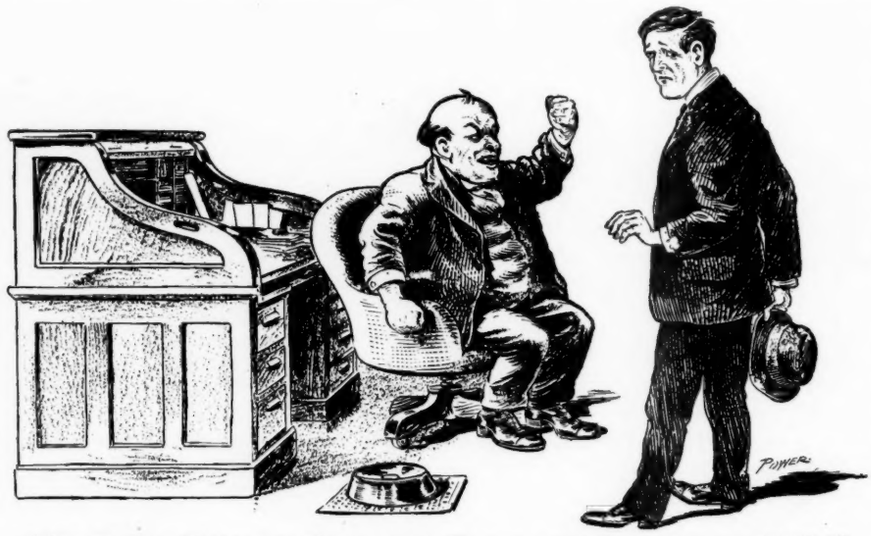
Bradley started to do things. He saw at a glance that there were no dampers and that the ashpit doors were missing, hence, the boilers were cold. He ordered Olsen, the fireman, to clean out the combustion chambers as they were full, and the fuel used was soft coal. He found that the boilers were fed through the blowoff pipes and that the city mains were connected thereto. In three minutes the blowoffs were clear and the water going out. Bradley then dropped in the top manhole plate, and Olsen passed up the hose. Jenkins, seeing this exhibition, retreated into the engine room, vowing with profane earnestness that he had enough packing to do to last out the rest of the day, and casually remarked that no red-haired boiler inspector could learn him anything about a boiler, or anything else on this "dashed" sphere, and he would be "blinked-blanked" if he could. At this outburst the fireman grinned almost humanly, as Brad winked on receiving the information. The boilers were soon cold and ready for internal inspection.

Bradley made the inspection, tested the steam gage, renewed the plug, and had Olsen clean the lower pipes to the water column. When all was done, Jenkins came into the boiler room and said, "Well, they are good boilers, ain't they?"

Brad replied that he had seen worse and inquired why there was no damper.

"I'll tell you," said Jenkins, "Bildad don't pay me enough to improve things. I don't do anything to fix the plant up till I get a raise. I have been here three months and he is the coldest 'blank' proposition I have ever met. No sir, if he wants things fixed up, he will have to dig up more coin for me."

So Bradley went upstairs to find the watchman to let him out. When he reached the office he met Mr. Bildad, and being introduced by the watchman, the usual inquiries were made as to conditions, etc. Bradley politely informed Mr. Bildad on the subjects in question, but omitted any reference to Jenkins or the work required in getting the boilers ready.



"How do You Propose to Settle this Matter with Me about the $1400?"

Just as he was about to leave, Bradley blandly inquired, "Do you own a coal mine, Mr. Bildad?"

Bildad flashed back, "No, why do you ask?"

"Why I see that you have no dampers on your boilers and no ashpit doors," said Bradley.

"What do you mean?" said Bildad, whose soul was wrapped up in paper-box machinery and in chasing dollars into a bank account.

"Come down and I'll show you," said Bradley.

Down they went, and Bradley laid out a place for a damper, explaining that when it was closed at 5 p.m. the heat could be held in the furnace so that steam could be gotten up to 70 or 80 pounds pressure at 6:30 a.m. without any additional fuel being needed, and that heat could be stored up over Sunday, as the brickwork would give out the heat it had absorbed in a manner similar to that in which a flywheel gives up the energy stored in it. He also pointed out the value of having ashpit doors, and concluded with the remark that the investment of a few dollars in the direction pointed out would result in a handsome saving for Mr. Bildad, as probably two tons of coal per day could be saved in this manner.

Bildad asked Jenkins how much coal it took to get up steam in the morning. He was referred to the watchman for information, as Jenkins had other things to look after that were crowding him, and furthermore, he needed more help to handle the plant.

Braldey excused himself and departed for Bilton's, where Jones, the engineer, had the boilers in perfect readiness for inspection, and where conditions were the opposite of those at the Bildad outfit. In the joy and pleasure of meeting a mechanic and a gentleman and of going over the details of a fine plant, he speedily and completely forgot about the Bildad affair.

Some 30 days later, a telephone message was received to the effect that Bradley was wanted at Bildad's place. On Bradley's arrival at the office, Bildad picked up a sheet of paper and informed Bradley that he had at once installed the dampers and ashpit doors and found that he was saving two tons of coal per day. This coal cost $2.35 per ton. Assuming a 300-day year, this would result in the saving of $1400 per year. The cost of the improvement had been $75.

Fixing Bradley with a cold stare, Bildad remarked that in 10 years the saving would amount to $14,000, whereat Bradley grinned and remarked that that would be about right; for seldom indeed

does a boiler inspector receive a bouqet, being more accustomed to bricks.

"Now," said Bildad, "I find that you inspected my boilers a year ago and made no mention in your report of the fact that they had no dampers. I pay good money to your company for your services, and I am out $1400 because you did not do your full duty at that time. If I report this matter to your company, you will be out of a job. How do you propose to settle this matter with me about the $1400?"

The bouquet had vanished, the bricks had materialized. Bradley smilingly advised Bildad to sue his company, as he really was their agent and that personally he felt that the best thing that he could do, as an inspector with a battered and damaged reputation, was to jump off the dock and terminate his miserable existence.

Say now, after all, do you really blame old Jenkins!

Increasing Capacity of Steam Boilers

By Henry Kreisinger and Walter T. Ray

The output of a boiler depends upon the quantity of gases passing through it, other things being equal; by increasing the grate area and the velocity of the gases the steaming capacity is increased proportionately. It seems within the limit of practicability to double the grate area and the gas velocity without increasing the floor space required, and thus quadruple the present normal rate of steaming.

The substance of our article, "Heat Transmission into Boilers," published in the June 29, 1909, issue of POWER, can be summarized briefly as follows:

The economy of steam boilers can be improved by making the gas passages smaller as compared to their length; that is, arranging the heating plates in such a way that the average distance of the hot-gas particles from the dry surface is short. In boilers already installed, the economy can be improved by making the gas passages longer, that is, by inserting baffles into the path of the gases in such a way as to put portions of the heating plates into series so that the same body of gas passes one portion of the heating plate after another.

The capacity of any boiler can be increased by passing over the heating plates a larger weight of gases. The conductivity of the metal of the heating plates is so great that the plates themselves will transmit any quantity of heat that the hot gases can impart to them.

Recently, the high ability of the heating plates to transmit heat, and the great possibilities of increasing by many times the present rate of working steam boilers have been much discussed.

The purpose of this article is to investigate the above suggested methods of increasing the economy and particularly the capacity of steam boilers and to find out how far such increases are practicable.

While it is true that the heating plate of a boiler can transmit many times the quantity of heat that it does at present, it should not be forgotten that the passage through the plate is only a short part of the whole path of the heat travel. A considerable part of this path has to be passed over before the heat reaches the dry surface of the heating plate, and it is this portion of the path which will present serious difficulties to the efforts to increase boiler capacity. In other words, the question is not how much heat the boiler plate can transmit but how much heat can be imparted to its dry surface.

Another difficulty may be encountered in the generation of larger quantities of heat. To produce three or four times the weight of hot gases, three or four times as much coal must be burned. There are many furnaces, particularly those of the hand-fired type, which waste much coal in imperfect combustion even at the present rate of working.

The gases of combustion serve as the heat carrier. To bring more heat to the dry surface of the heating plate, more gases must be passed over it. Therefore, any proposition to increase the rate of working of steam boilers must include the problem of forcing the hot gases over the heating plates. To force a large quantity of hot gas through boilers as they are constructed at present will require high pressures (drafts), and the latter must be still higher if the gas passages are made longer and smaller in cross-section for the purpose of obtaining better economy. It will cost money to install fans to produce such high pressures and it may be found expensive to operate these fans, unless they, and the motors driving them, are made much more efficient than they are at present. It is, particularly, the cost of operation of these high-pressure fans that seems to set a limit to the high rate of working steam boilers. However, a thorough analysis of the problem will reveal that the limit is not so near as it may at first appear to be.

Numerous experiments, reported in the United States Geological Survey bulletin No. 367, indicate that the power required to drive the fan increases approximately as the cube of the capacity of the boiler which the fan supplies with air. Thus, to double the capacity of a boiler the work of the fan must be increased not by 2, but by 2^3 or 8.

This high rate of increase in the fan work is due to two causes: First, a larger weight and consequently larger volume of gas must be forced through the boiler; second, in order that a large weight of gas shall flow through the boiler, the pressure drop (draft) through it must be increased. The pressure drop increases approximately as the square of the weight of the gas to be pushed through the boiler. The work of the fan increases directly as the volume of gas and directly as the pressure against which the volume of gas is displaced.

In Fig. 1 are given plotted data of a series of locomotive tests, showing how the "square" law of the pressure drop agrees with actual results. The data are taken from the United States Geological Survey bulletin No. 412. The total pressure drop between ash pan and smoke box for various outputs is plotted from 14 locomotive-boiler tests. Four of the tests were made with small, round briquets, four with large, square briquets and six with run-of-mine coal. Each of the three fuels forms a curve of its own. The curves of the briquets are more reliable because the run-of-mine coal contains a large quantity of slack, which, when using the high-pressure drops, was carried out of the furnace before it had time to burn, thus resulting in a loss of the potential heat of the fine coal.*

Referring to the curve for the small briquets, when the total pressure drop was 2 inches of water, the boiler developed about 365 horsepower. To double this capacity, or, to develop 730 horsepower, the pressure drop had to be increased to about 8.5 inches of water, which is a little more than 2^2 times the pressure drop required in the first case. Again, with a total pressure drop of 3 inches the capacity developed by the

*For more detailed description of these tests see United States Geological Survey *Bulletin* No. 412.

boiler was about 435 horsepower. To develop twice this capacity, or 870 horsepower, the total pressure drop had to be increased to about 12.2 inches of water, which is about 2^2 times that necessary for 435 horsepower. The curve for the large briquets shows a similar relation. This relation indicated by the curves shows that the law of "squares" holds with fair accuracy for the capacity range which was covered by these tests, and that it is not at all a bad one to use in speculative calculation.†

The product of the pressure drop and the volume of gases displaced is equal, or proportional to the work done by the fan. Since the first increases about as the square of the capacity, and the second directly as the capacity of the boiler, the work of the fan increases about as the cube of the capacity.

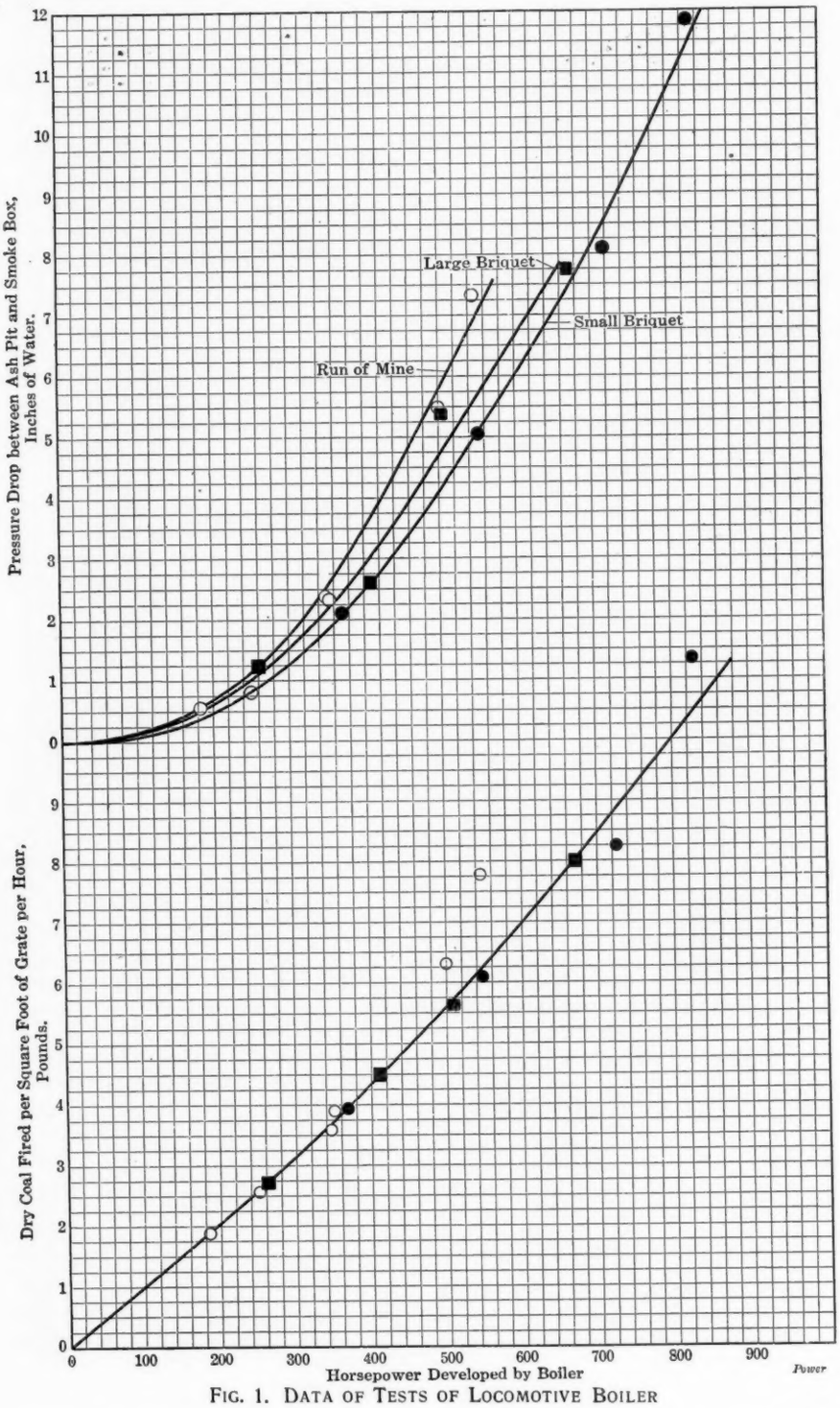

Pressure Drop between Ash Pit and Smoke Box, Inches of Water.
Dry Coal Fired per Square Foot of Grate per Hour, Pounds.
Horsepower Developed by Boiler
Large Briquet
Small Briquet
Run of Mine
Power

FIG. 1. DATA OF TESTS OF LOCOMOTIVE BOILER

The work of the fan for single capacity (capacity of 100 per cent.) can be expressed by the equation,

$$Work = volume \times pressure;$$

hence the work for double capacity (200 per cent.) is,

$$Work = 2 \times volume \times 2^2 \times pressure$$
$$= 8 \times volume \times pressure$$

and the work for triple capacity is,

$$Work = 3 \times volume \times 3^2 \times pressure$$
$$= 27 \times volume \times pressure$$

By the application of this approximate law of the rate of increase of volume and pressure, the work of the fan can be computed for any multiple capacity with reasonable accuracy.

As a specific example let us take a battery of boilers which ordinarily develops 1000 horsepower. Let this battery of boilers be operated by a fan which requires 10 mechanical horsepower to drive it. With present fan practice this figure would perhaps be considered low, and the operation of the fan would be considered economical. Assuming that the fan engine develops one mechanical horsepower on one boiler horsepower, the steam consumed by the engine will be 1 per cent. of the total steam made. Suppose, now, that it is desired to double the capacity of this boiler battery. According to the law of heat transmission this can be done by forcing a little over twice the weight of gases at the same temperature through the battery. In order to do this the difference between the gas pressures at the ends of the boiler must be increased about four times; that is, if an exhaust fan is used the negative pressure in the uptake must be made four times what it was before, or, if a pressure fan is used the pressure in the ashpit must be increased to four times what it was before, counting the pressure in both cases below or above that of the atmosphere. The work the fan would have to do in the case of double capacity would be,

$$2 \times 2^2 \times 10\ horsepower = 80\ horsepower$$

In a similar way, we find for triple capacity of the battery the required fan power to be,

$$3 \times 3^2 \times 10\ horsepower = 270\ horsepower$$

Although the fan work in the case of single (100 per cent.) capacity of the battery may seem insignificant, it becomes alarmingly large when the capacity is tripled or quadrupled. It would seem that this increase in the rate of steam production could not be carried very far before most of the steam generated in the boilers would have to be used for forcing the gases through the furnaces and boilers.

Table 1 gives the fan work required for the multiple capacities, and other related items calculated from the previously discussed "cube" law.

According to the values given in the third vertical column, to have the boiler battery develop ten times the ordinary capacity the fan engine would have to be one thousand times as powerful as for the normal capacity. The last vertical column shows that at the tenfold capacity, the fan engine would consume

†For further proof of this law see page 29 of the United States Geological Survey *Bulletin* No. 367.

nearly all of the steam the boilers would generate. If the steam consumption of the fan engine were 2 per cent. when the boilers are run at their normal rate, their capacity could not be raised above seven times the normal rating.

It would seem that under such conditions it would not be practicable to increase the capacity of ordinary steam boilers more than three times, and that of boilers of improved efficiency possibly four times.

The steam consumption, assumed above, of 1 per cent. of the total steam generated may perhaps seem too low for the present inefficient fans and crude engines sometimes set to drive them. However, for fans of better design, having a mechanical efficiency of 75 per cent., or more, and driven by more economical engines, the assumed consumption is more than high enough. It may surprise some readers to know that the mechanical efficiency of most of the fans used at present for draft purposes ranges between 10 and 50 per cent., many probably closer to 10 than to 50.

It may be interesting to know the theoretical amount of work done by a fan in an ordinary case, that is, the work the fan really does by displacing the air against the pressure in forcing it through the boiler. Let us take the same hypothetical battery of boilers which, under normal conditions, develops 1000 boiler horsepower, and compute the useful work done by the fan. We shall assume that when the battery is operated at normal rate the pressure drop from the ashpits to the uptakes is 1 inch of water. Let us also assume that the coal burns with 15 pounds of air per pound of dry coal, which would be considered a good performance. Further, let us assume that the equivalent evaporation per pound of dry coal is 10 pounds, which will make the overall efficiency of the boiler and furnace about 70 per cent. We get, then, the following figures for the battery of boilers when developing 1000 horsepower.

Total, equivalent water evaporated per hour	34,500 lb.
Total dry coal consumed per hour, $\frac{34,500}{10}$ equals	3,450 lb.
Total weight of air delivered per hour equals	51,750 lb.
Total volume of air at 70° F. delivered per hour equals	672,750 cu.ft.
Pressure of one inch of water equals about $\frac{1}{28}$ lb. per square inch.	

The work done by the fan per minute in pushing the gas through the furnaces and boilers equals,

$$11{,}212 \times 144 \times \tfrac{1}{28} = 55{,}673 \textit{ foot-pounds}$$

and the power expended in doing this work equals,

$$\frac{55{,}673}{33{,}000} = 1.68 \textit{ horsepower}$$

This is the power actually needed to push the gases through the fuel beds and the boilers when they are developing 1000 boiler horsepower. If a fan of 75 per cent. efficiency is employed, the power delivered to the shaft of the fan would be,

$$\frac{1.68}{0.75} = 2.25 \textit{ horsepower}$$

The next question is, how much of the steam generated would have to be consumed to obtain the necessary power to drive the fan. If a crude, independent steam engine is used, the steam consumption will be all the way from 50 to 100 pounds per horsepower-hour. If, however, the battery is in one of the large central stations where electrical energy is generated in large units and where the fan can be driven by an efficient electric motor, the steam consumption chargeable to running the fan is a negligible quantity. A large steam-turbine unit can generate an electrical horsepower-hour on 10 to 12 pounds of steam. Taking the efficiency of the motor at 80 per cent., the steam consumption accountable to the fan would be,

$$\frac{2.25}{0.80} \times 12 = 33.8, \text{ or } 34 \textit{ pounds}$$

which is perhaps somewhat more than one boiler horsepower, or about 0.125 per cent. of the total steam generated. Under such conditions it would be possible to increase the capacity of steam boilers several times before a limit would be reached in the cost of draft production. Calculations made on bases like this are more favorable to high rates of working than those given in Table 1. In Table 2 are given the calculated values of the power required and the steam consumed by the fan, based on these conditions, when the boilers are forced to higher capacities; the calculations are referred to the theoretically figured values for normal capacity. It will be noticed that values of the steam accounted to the fan are reasonably low even at 7- and 8-fold capacities, which indicates the practicability of high rates of working in large plants.

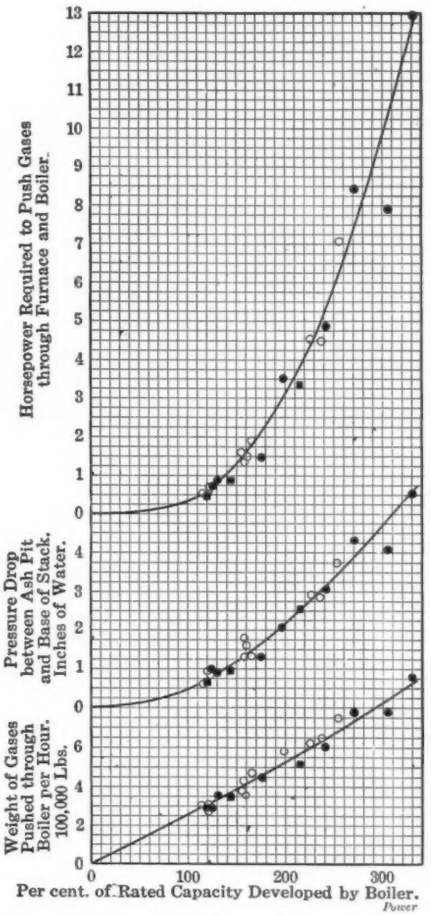

Horsepower Required to Push Gases through Furnace and Boiler.
Pressure Drop between Ash Pit and Base of Stack. Inches of Water.
Weight of Gases Pushed through Boiler per Hour. 100,000 Lbs.
0
100
200
300
Per cent. of Rated Capacity Developed by Boiler.
Power

FIG. 2. DATA OF TESTS OF TORPEDO BOAT BOILER

TABLE 1. RELATION BETWEEN BOILER OUTPUT AND STEAM CONSUMPTION OF ENGINE-DRIVEN FAN.

Capacity of Boiler Battery, Per Cent. of Rating.	Boiler Horsepower Developed by Boiler Battery.	Relative Work of Fan.	Steam Consumed by Fan Engine, Expressed in Boiler Horsepower.	Steam Consumed by Fan Engine in Per Cent. of Total Steam Generated.
100	1,000	1	10	1
200	2,000	8	80	4
300	3,000	27	270	9
400	4,000	64	640	16
500	5,000	125	1,250	25
600	6,000	216	2,160	36
700	7,000	340	3,400	49
800	8,000	512	5,120	64
900	9,000	819	8,190	81
1,000	10,000	1,000	10,000	100

TABLE 2. RELATION BETWEEN BOILER OUTPUT AND STEAM CONSUMPTION OF MOTOR-DRIVEN FAN.

Capacity of Boiler Battery, Per Cent. of Normal Rating.	Boiler Horsepower Developed by Boiler Battery.	Power Required to Run the Fan, Mechanical Horsepower.	Steam Accountable to Fan per Hour, Pounds.	Steam Accountable to Fan, Per Cent. of Total Steam Generated.
100	1,000	2.25	34	0.125
200	2,000	18.00	272	0.500
300	3,000	60.75	918	1.125
400	4,000	144.00	2,056	2.00
500	5,000	281.25	4,250	3.125
600	6,000	485.00	7,344	4.500
700	7,000	771.75	11,662	6.125
800	8,000	1,156.00	17,408	8.000
900	9,000	1,640.00	24,786	10.125
1,000	10,000	2,250.00	34,000	12.500

Fig. 2 is presented to show how closely the results obtained in actual tests agree with the computed values given in Table 2. In this figure are plotted some of the data and results of a series of 21 tests made of a Normand water-tube boiler on the United States torpedo boat "Biddle." These tests were made with three kinds of fuel, namely, run-of-mine coal, represented in the figure by hollow circles, small briquets, represented by solid circles, and large briquets represented by solid squares. The boiler contained 2770 square feet of heating surface and therefore its capacity in stationary-boiler prac-

tice would be considered to be 277 boiler horsepower.‡

The lowest curve shows the relation between the capacity developed by the boiler and the weight of gases passed through the boiler and furnace per hour. The latter has been computed from the weight of coal burned and the flue-gas analysis. The curve shows that the capacity of the boiler increases nearly but not quite as fast as the weight of gases passing through the furnace and boiler. Thus, when the capacity is 110 per cent., the weight of the gases is about 275,000 pounds; when the capacity is 220 per cent. or twice as much, the weight of gases is about 575,000 pounds or a little over twice as much as in the first case, and when the capacity is 330 per cent., the weight of the gases is about 920,000 pounds or a little over three times as much as the original quantity.

The middle curve shows the relation between the capacity and the gas-pressure drop (draft) between the ashpit and the base of the stack. This curve shows that the total pressure drop increases very nearly as the square of the capacity. Thus, when the capacity is 110 per cent., the total pressure drop is about 0.63 of an inch of water; for double that capacity the pressure drop is about 2.6 inches, or about four times as much as in the first case, and for 330 per cent. capacity, the pressure drop is about 6.5 inches, or about nine times as much as for 110 per cent. capacity.

The curve at the top of the figure gives the relation between the capacity and the horsepower required to push the gases through the furnace and the boiler. The power has been computed from the total pressure drops and the volume of air displaced, the latter being figured from the data of the lowest curve. An examination of this top curve will show that the power required to move the air increases very nearly as the cube of the capacity. Thus, for the three capacities of 110, 220 and 330 per cent., the horsepowers required to move the air are 0.5, 4 and 13, which are respectively proportional to 1, 8 and 27.

The pressure difference was obtained by forcing air into the fire room and maintaining a pressure therein. The wheel of the blower supplying the air was 5 feet in diameter and was placed directly in the fire room. The blower had no casing, the wheel was protected by a wire screen; thus there were no ducts and, consequently, no leakage losses. The blades of the wheel were curved in the direction opposite to that of the rotation of the wheel. This construction, together with the omission of the casing, made the blower highly efficient. The steam engine driving the fan was capable of developing about 20 to 25 horsepower; its maximum speed was 1000 revolutions per minute.

The results of the tests on the torpedo boat show that it is possible to obtain a high capacity of boiler at a low cost for the draft. When the boiler was working at a capacity of 330 per cent. it took about 13 horsepower to push the gases through the boiler. At this rate of working the power delivered to the shaft of the blower was, very likely, less than 20 horsepower, which is about 2 per cent. of the energy which can be developed from the total steam made in the boiler.

In stationary-boiler plants present practice with mechanical draft shows that the steam consumption at normal rates of working is 1 to 2 per cent. of the total steam generated in the boiler, and even higher. Of the available power in the steam thus used only a small fraction is utilized in pushing the gases through the furnaces and boilers. The balance of the power is wasted by crude steam engines, inefficient fans, long, narrow air ducts having sharp turns, and numerous leaks.

The reason for the low efficiency of the existing mechanical-draft appliances is this: The power actually needed to move the gases through the boilers is so low that although the draft apparatus may consume several times this necessary amount, the total power put into the apparatus is still so low that it would not pay to save part of it at the price of increased first cost for draft apparatus. It would hardly be good economics to spend several hundred dollars for more efficient fans and motors, and the construction of large air ducts to save about 1 per cent. on the coal bill. In the future, however, if boilers are worked three or four times as hard as they are at present, the power required to push the gases through the boiler will increase to a considerable magnitude so that it will pay to install draft apparatus of high efficiency. At the same time, by a proper design of the boiler plant, the first cost of the draft installation can be greatly reduced. Thus, it may be possible to shorten the length of large, expensive air ducts by placing independent fans for each battery of boilers either on top or under the boilers which they operate. Even if the fans consume twice as much power as Table 2 indicates, the cost of draft at high capacities would be reasonable.

From the foregoing consideration of the cost of draft production we may conclude that it seems practicable to increase the rate of working steam boilers to three, four and possibly five times the present rate. The cost of installing highly efficient draft apparatus of high pressure and high capacity will be small compared with the saving of the cost of installing extra boilers.

We have already stated that in order to have a highly efficient boiler the individual gas passages must be made small in cross-section as compared to the length. Now, if large volumes of gas are to be forced through these passages its velocity will necessarily be high. This high velocity of gas will be beneficial to the outside cleanliness of the boiler, as it will be almost impossible for any soot or ash to collect on the heating plates, and reduce the efficiency.

In the furnace, however, excessively high velocity is not desirable. Large volumes of hot gases can only be produced by burning large quantities of coal. The burning of large quantities of coal in furnaces with the present small grate areas and combustion spaces would necessarily be attended by a rapid flow of gas through the furnace. If the velocity of air through the fuel bed is high, the small pieces of coal are likely to be lifted and carried out of the furnace. Or, if the velocity of gases through the combustion space is too high, the combustible gases distilled from the fuel bed will pass through the space before they are burned.

The velocity of gas through the fuel can be reduced by making the grate area larger. This velocity of the gases is inversely proportional to the area of the grate; that is, doubling the grate area reduces the velocity to one-half, tripling the area reduces the velocity to one-third. In most of the present boiler installations there is plenty of space under the boiler for at least double the grate area.

The velocity of the gases through the combustion space can be reduced by increasing the combustion space. This can be done perhaps by raising the boiler, which is possible in almost any boiler room. The combustion in many cases can be improved by using proper mechanical stokers which are operated on the principle of slowly heating the fresh fuel. It is evident that with boilers run at high capacities the furnace will be the large part of the steam-generating apparatus.

By doubling the grate area and doubling the present velocity of gases through the furnace, about four times the amount of coal could be burned, resulting in four times the weight of hot gases. By doubling or tripling the present effective combustion space and by the use of proper mechanical stokers the combustion of the gases would be fairly complete before they would enter the boiler proper. Thus, it seems possible to increase the capacity of steam-generating apparatus three or four times without having the steam apparatus take any more floor space than it does for the present "normal" rate of working.

‡For further details of tests see United States Geological Survey bulletin No. 403.

The output of coal from the collieries in Natal during the year 1909 amounted to 1,786,583 tons, which is the highest total reached since the commencement of the industry.

Carroll's Carbonic Acid Engine

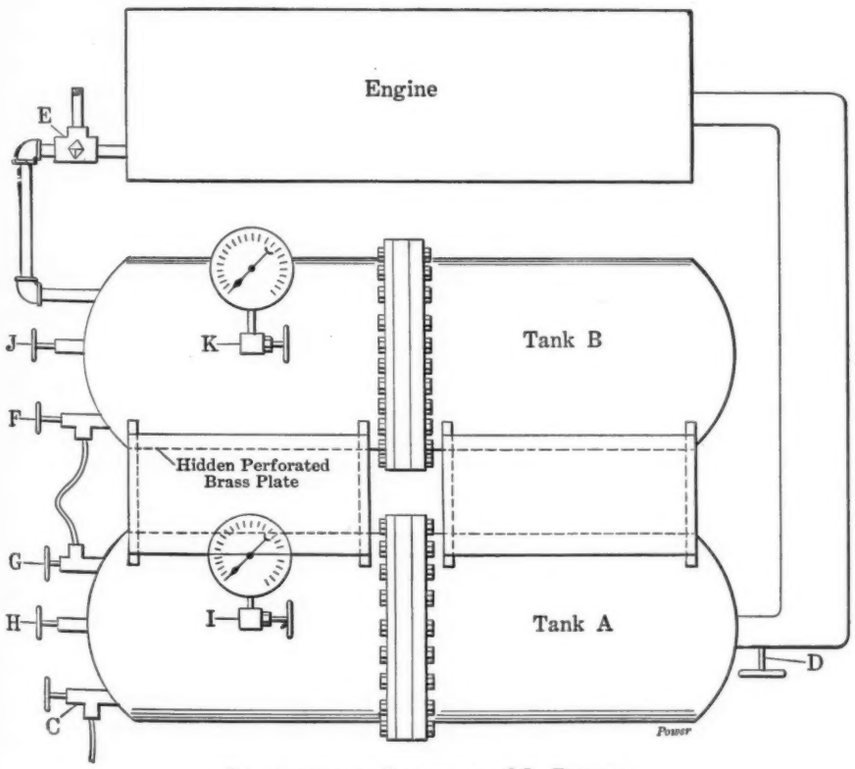
By Our Special Correspondent

When we learned that John E. Carroll was operating in Boston the Carbonic Acid Gas swindle which we were instrumental in breaking up in Philadelphia in 1907, we commissioned a local mechanical engineer to try to find out how the game was worked. He attended a number of the demonstrations, and this article gives his impressions and a suggestion as to how the Carroll engine is made to run apparently against a back pressure greater than the pressure which is driving it.

John E. Carroll, who made demonstrations of a CO_2 engine in Philadelphia some time ago, is now making demonstrations at 304 Columbus avenue, Boston. The engines in use are evidently the same ones which were used at Philadelphia, with possibly some modifications.

There are three engines, one being a small three-cylinder engine attached to an automobile frame, which engine is run by direct pressure from a tank of compressed CO_2 and exhausts directly to the atmosphere. This engine can be run at a high rate of speed and almost instantly reversed by means of a small lever.

Another larger engine, with three cylinders and six pistons, is connected to an automobile frame, and is used on the streets to demonstrate the power which this engine can develop and the readiness with which it can be controlled. Connected with the engine on this frame are three cylinders; the central one is an auxiliary cylinder which simply carries an extra supply of CO_2 gas under the usual tank pressure. The charging cylinder on the left-hand side is the one supplying the engine with CO_2 gas. The engine exhausts into one end of the third, or "regenerating cylinder," while the other end of the cylinder is connected by means of a tube to the charging cylinder. The middle, or auxiliary cylinder, can also be opened into this tube, thus supplying an additional charge of CO_2 to the charging cylinder. However, in practical operation of the engine, this valve is closed and the charging cylinder supplies the engine, and the exhaust enters the "regenerating cylinder," which is supposed to regenerate the pressure by means of liquefaction and regassification and deliver its regenerated gas into the charging cylinder, whereby it can be used again.



DIAGRAMMATIC SKETCH OF CO_2 ENGINE

The charging cylinder is said to contain kerosene and salt, which is said to extract the moisture from the CO_2 gas and, according to the claims made by the inventor, the extraction of moisture from any gas produces a great deal of heat, thereby raising the temperature of the gas several hundred degrees. A small amount of air is said to be introduced into the cylinders through the pistons for the purpose of facilitating the expansion of the gas. The "regenerating cylinder" is said to contain a number of cylinders, with perfect vacuum and heat insulating material between them, to facilitate the liquefaction of the gas.

The company claims to have affidavits to the effect that this engine was run continuously for 72 hours, generating 31 brake-horsepower on an initial charge of one-half pound of liquid gas, the exhaust gas being regenerated into gas of high pressure and reused again and again. *However, no one of our acquaintance has witnessed any demonstrations of any great length, in fact, of no longer duration than could be expected from the expansion to atmospheric pressure of such a quantity of gas as the cylinders would contain from the initial charging.*

Mr. Carroll frequently opens a three-way cock so that the engine exhausts directly to the atmosphere without entering the "regenerating cylinder." Under these circumstances there is a sharp exhaust, as would be expected from such an engine being operated by compressed air or other gas, but when this valve is turned so that the exhaust escapes into the cylinder, there is no back pressure or noise, due, in all probability, to the gas finding a free and muffled passageway to the atmosphere from the underside of this cylinder. A close observation of the "regenerating cylinder" shows that on its under side there is a hole cut into the casting, which is evidently covered by some gauze or perforated metal, through which the exhaust may escape to the atmosphere without making any appreciable noise.

The other engine is shown in the accompanying sketch and is said to be a reconstructed gas engine and not designed especially for use with carbonic-acid gas. This engine is mounted on a frame supported by four wheels, so that it can be rolled about on the floor to satisfy observers that there are no hidden connections of any kind. On this same frame there are two tanks about 10 inches in diameter and some 30 inches in length. Each tank is divided in the middle and held together by means of several bolts fastened through flanges. Tank *A* is shown as the charging tank and *B* is called the "regenerating tank."

The method of procedure during a demonstration is usually to charge tank

A through valve *C* from a commercial cylinder of CO_2. Gas is usually admitted to this cylinder until it attains a pressure of about 600 pounds. The gage on tank *B* is standing at zero pressure and to absolutely demonstrate that there is no pressure even on the under side of valve *K*, this valve is completely removed. The operation of the engine is said to be as follows: By opening valve *D*, or its equivalent at the admission valves of the engine itself, the gas passes from tank *A* through the engine and straight through the three-way cock *E*, to the regenerating tank *B*. In the meantime, valve *K* has been replaced and closed. After running the engine several minutes, the pressure gage on tank *A* is noted to be very nearly zero, it having gradually dropped from the original pressure of 600 pounds. Valve *K* is usually opened at this time and this gage shows a pressure of between 575 and 600 pounds, which is said to have been regenerated from the exhaust gas of the engine. By opening valve *F* and valve *G* the pressures in tanks *A* and *B* equalize according to their respective gages and the speed of the engine can again be increased and the engine run for some time. By closing valve *F* or *G*, the pressure gage of tank *A* continues to drop as the engine is operated, while the pressure gage on tank *B* remains stationary; or, if valves *F* and *G* are both left open, the two gages drop together. In cases when valves *F* and *G* are closed and the pressure in tank *A* is allowed to drop more rapidly than the pressure of tank *B*, the two gases equalize upon these two valves being reopened, while the pressure in tank *B* has never been seen to increase a second time during the same demonstration.

This engine is connected by means of a gear to a three-kilowatt generator which furnishes power for about 20 eight-candlepower lamps for a period of about three minutes. When developing this power, the pressure in tank *A* drops at the rate of about 100 pounds per minute. The engine ran for a longer period but it did not have sufficient speed nor power to keep the lights burning longer than about three minutes.

During a demonstration the three-way cock *E* is frequently opened to the atmosphere by the demonstrator and a sharp exhaust is heard, but when this is turned into the regenerating tank *B*, there is no appreciable sound nor any change in the speed of the engine from that which existed when this valve was opened direct to the atmosphere. It is frequently demonstrated that this engine will not run against any appreciable back pressure by connecting a small tank and gage onto the open end of cock *E*. As the attached pressure gage rises, the speed of the engine is immediately reduced until it finally comes almost to a standstill, hence it is evident that when the engine is exhausting direct into tank *B* there is no more back pressure than exists when it is exhausting directly to the atmosphere. A careful observation of this tank shows that on the under side, next to the exhaust entrance, hidden beneath the supports, is a brass plate with a great number of small holes, which is evidently used to muffle the exhaust from the engine and allow it to escape to the atmosphere.

The method of indicating an apparent regeneration of pressure on tank *B* is explained by the following usual method of opening and closing the valves by the demonstrator. As stated before, the initial charge is admitted through valve *C*, valves *F*, *G*, *I* and *K* being open while valves *D* and *J* are closed. After tank *A* has been charged to 600 pounds pressure, valve *C* and either *F* or *G*, or both, are closed, and when it is desired to start the engine valve *D* or its equivalent is opened, and the three-way cock *E*, set so that the exhaust escapes into tank *B*. In the meantime, valve *K* has been replaced and closed while *J* is opened. There are also some adjustments made on valve *H*. After the pressure gage in tank *A* has been reduced several hundred pounds, or to atmospheric pressure, valve *K* is opened, showing almost 600 pounds pressure, or a little less than the initial pressure in tank *A*, upon the gage of tank *B*, and by opening valves *F* and *G* the two pressure gages equalize, as previously described. It is very evident that a section of tank *B*, which is said to contain several tanks, is charged through valves *F* and *G* at the same time tank *A* is charged, and by means of the two valves *J* and *K* between this concealed tank and pressure gage *B*, the demonstration by which the pressure is apparently regenerated in tank *B* can readily be made in such a manner that it will fool the average observer not familiar with mechanical apparatus.

The pressure gage on tank *B* has never been known to increase gradually, as the gage is always closed from the tank while the supposed regeneration is in process. It has also been noted that when valve *K* to the pressure gage on tank *B* is opened it never exceeds the initial pressure in tank *A* whether it be 600, 400 or 300 pounds; also that there is never a second rise in the pressure of tank *B* during the same demonstration.

Commercial Fuel Briquet Plant

By W. H. Blauvelt

The numerous failures of briquet-manufacturing plants during the past few years have been largely caused by insufficient preliminary study of the conditions of supply and demand. A plant that is now operating on a successful commercial basis is that of the Solvay Process Company and Semet-Solvay Company, at Detroit, Mich. This plant produces small briquets of the egget form by the use of the rotary type of press. Special attention is given to the selection of raw material and the process of manufacture.

The subject of fuel briquetting has attracted much attention on the part of engineers and investors for the past fifteen or twenty years, and especially in recent years, during which time a number of plants have been built with more or less commercial and technical success.

The greater part of the failures in this line have been due entirely to commercial causes. Before undertaking the installation of a plant for the manufacture of briquets, it is necessary that the local conditions be examined carefully: First, to determine the kind of briquets, if any, the market will demand; and second to find out if there is an available supply of raw material, such as coal, coke, pitch, etc., which can be worked up into briquets that will meet the market conditions, and can be obtained at a price that will leave a margin for the cost of manufacturing and a reasonable profit. If this preliminary investigation does not result satisfactorily the manufacturer should carry his plans to another locality.

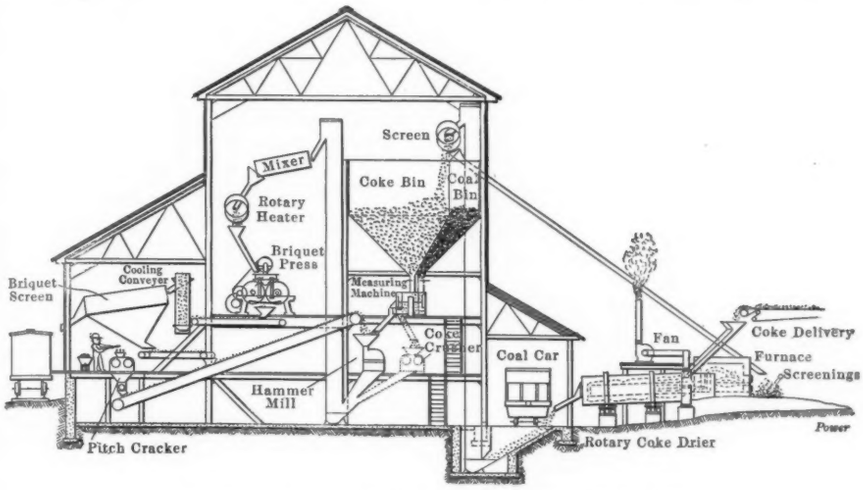
The next step is the selection of the process of manufacture best adapted to the conditions. A number of different processes have been developed, both in Europe and the United States, it having reached large proportions in continental Europe. The usual shape of the European briquet is that of a rectangular block with rounded edges, and weighing from 0.5 to 10 kilograms, although small briquets of the egget form are used to some extent in Belgium and France.

The eggets are made on rotary presses, the coal and binder being pressed between the cupped faces of the rolls. Generally speaking, it is not practicable on these rotary presses to produce briquets larger than about 6 ounces in weight. On the other hand, the capacity of the re-

*Abstract from a paper presented at a meeting of the American Institute of Mining Engineers, at Pittsburg.

ciprocating presses used in making the large briquets falls off rapidly as the size decreases.

The purpose of this article is to describe the briquet plant of the Solvay Process Company and the Semet-Solvay Company at Detroit, Mich., which, after a period of long and costly evolution, is now operating satisfactorily on a commercial basis.



SECTIONAL VIEW OF SOLVAY BRIQUETTING PLANT

This plant produces, by the use of the rotary press, small briquets, or eggets, of about 2 ounces in weight. The raw materials used are coke breeze from an adjacent coke-oven plant, and dry noncaking coal from nearby districts. These materials are used in equal proportions, by weight, and mixed with from 8 to 9 per cent. of the binder. Coal-tar pitch is used as a binder on account of its waterproofing qualities and comparatively moderate cost. It is used hard and ground to a fine powder.

The accompanying diagram shows the general arrangement of the plant.

The process as at present conducted is essentially as follows: The coal is unloaded into a track hopper and elevated into the coal bin. As slack coal is used, no preliminary crushing is necessary. The coke breeze usually contains considerable moisture, so in order to maintain constant conditions, the breeze is dried in a rotary drier before being elevated to the storage bins. The coal and coke are brought together from the bins into a measuring machine, which delivers the two materials in any desired proportion to a hammer mill, in which the mixture is finely ground. The pitch which meets the coal and coke in this mill is brought from the pitch storage shed by an attendant who breaks it into pieces of convenient size for feeding into the pitch cracker. The crushed pitch falls from the cracker into a small hopper from which a screw conveyer delivers a definite quantity to a belt conveyer, which in turn discharges the pitch into the mouth of the hammer mill, as above stated.

By grinding the coal, coke and pitch all together in the hammer mill the three materials are thoroughly mixed, which is the theoretical condition striven for. Practice has shown, however, that in pulverizing the coke breeze, the wear on the hammers of the mill has been excessive. Consequently it is planned to install a separate crusher for the coke as shown by the dotted lines.

The pulverized coke, coal and pitch are delivered direct to an elevator boot which lifts the mixture to the top of the building where it is conveyed to another mixer and then to a rotary heater where, by the means of superheated steam, it is heated to 80 degrees Centigrade. During the process a small amount of water is added to insure a pliant and readily moldable material for the press.

From the rotary heater the material is delivered to the rotary press. This press is made up of a heavy frame carrying two rolls. On each roll is keyed a gear carrying a steel tire with its face cupped in three rows. The gears are set to accurately mesh and thus bring the tires in rolling contact, with the cupped sections opposite one another. The press is driven by a motor with belt drive. Means of accurate control of the rolls is provided.

From the press the briquets are delivered to a cooling conveyer at the outside of the building. This permits them to cool sufficiently to cause the pitch to harden and lend strength to the briquet.

The capacity of the plant is from 9 to 10 tons of briquets per day.

Soap from Boiler Stops Engine

By J. W. Parker

There occurred at a woolen mill a short time ago, one of those peculiar accidents, which at first are very obscure, but after thorough investigation appear plain enough.

The power was furnished by two locomotive-type boilers, each rated at 80 horsepower. These supplied steam for manufacturing purposes as well as to a 24x60-inch beam condensing engine running at 50 revolutions per minute.

When the mill shut down at noon on the previous Saturday, everything about the steam plant was in its usual working condition. Not requiring any steam until the following Monday morning, the fires were allowed to burn out and the fireboxes were cleaned on Saturday afternoon. Early Monday morning the watchman built new fires, as usual, and had steam up in time to begin work at half past six.

Soon after starting the engine, the engineer noticed a pronounced snapping in the cylinder, which soon developed into a loud knock. He stopped the engine and looked over the plant in a general way without finding anything out of normal condition, so he started up again but with the same result, and was forced to stop again. The whole operating force were at their wit's end to solve the cause of the trouble, and while they were discussing the matter the foreman of the cloth-finishing room came in and remarked to the engineer: "You are not the only one in trouble this morning, the soap is nearly all gone out of my soap tank."

The above remark led to the discovery of the cause of the trouble, which proved to be as follows:

In the cloth-finishing department there was a large drying coil which was supplied with steam by a 2-inch pipe, from which a 1-inch pipe was run to the soap tank for boiling purposes. The condensation from the drying coil was conducted to a receiver and returned to the boiler by an Albany trap. On the previous Saturday, the valve in the soap-tank coil had been left open; hence when the steam went down in the boilers there was a partial vacuum formed, which caused the soap in the tank to be drawn into the coil. When the steam was gotten up again and entered the coil, the soap therein was returned by the trap to the boilers; this caused the water to foam and to be carried to the engine cylinder.

To remedy the trouble the trap was disconnected and the boilers were emptied and the engine gave no further trouble.

Aside from other expense it cost one day's production of the mill to learn that a check valve should have been put into the steam pipe between the soap tank and the coil.

Electrical Department

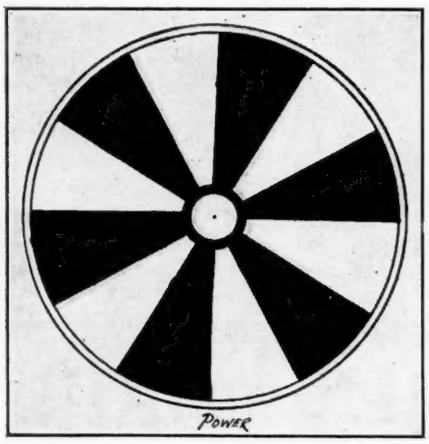
Especially conducted to be of interest and service to the men in charge of the electrical equipment.

Usefulness of the Stroboscope Illusion

By R. H. Fenkhausen

As stated in the editor's note following the article by Mr. Cartin in the April 12 issue of Power, the phenomenon there described is quite well known to the electrical fraternity. In view of the clear explanation offered by Mr. Cartin it seems strange that he states that the illusion occurred only when his arc lamps were fed from the busbars connected to the other power house, because it should have been equally evident when the lamps were fed from his own busbars; in that case, of course, the revolving fields would have appeared perfectly stationary, instead of revolving slowly back and forth, as in the former case.

The practical application of this optical illusion should be of interest to the readers of Power, and has often been used



Stroboscope Disk

by the writer. The exact slip of an induction motor at different loads is often desired, when making tests, but owing to the small amount of slip, usually about 6 per cent., and the variation of frequency common on commercial circuits, it is difficult to obtain unless a frequency meter is available, which is seldom the case except in very large plants.

Suppose, for example, that the frequency of a circuit is 59 cycles or one cycle slow. This often occurs in practice and represents an error of 1⅔ per cent. If a six-pole induction motor were tested out on this circuit under the assumption that the frequency is correct, quite a large error in the slip reading would result. The synchronous speed of a six-pole motor on a 60-cycle circuit is 1200 revolutions per minute, and on a 59-cycle circuit it would be 1180 revolutions per minute, the full-load slip in either case being about 80 revolutions.

Suppose that the speed of the motor, measured by a tachometer or revolution counter, is 1100 revolutions per minute at full load. This speed represents a slip of 100 revolutions at 60 cycles and only 80 revolutions at 59 cycles, so that if the frequency is assumed to be normal when it is in reality one cycle slow, the slip obtained will be 25 per cent. too high, which is a large error. Even when a frequency meter is available, the inaccuracy of the average instrument added to the error in reading and the probable changes in frequency during the duration of the test make close readings very difficult.

If a paper disk similar to Fig. 1 be attached to the shaft of any induction motor, and the disk illuminated by an arc lamp connected to the same alternating-current supply as the motor, the revolutions below synchronism may be counted while the motor is running, by noting the number of revolutions the disk appears to make in the reverse direction. As a synchronous motor or alternator has no "slip" the disk appears to stand still, which explains why Mr. Cartin's revolving field should appear stationary when his arc lamps are fed from his own busbars.

The paper disk must have as many black segments as there are poles in the motor; and its use is necessary because there are no visible poles on the rotor of an induction motor to give the optical effect, but in cases where the rotor spider contains as many arms as there are poles on the motor, the disk may be dispensed with and the apparent backward revolutions of the rotor arms observed. This is only possible, as a rule, on small machines which have four or six poles.

Some power houses use an induction motor as an auxiliary to a waterwheel-driven exciter, the induction motor acting as a generator and delivering power to the line at high water, and helping out the waterwheel at low water by running as a motor. If a paper disk properly segmented be attached to the motor shaft, it will give a visual indication of whether the motor is floating on the line, generating, or running as a motor, the disk appearing stationary in the first case, revolving with the motor in the second, and revolving backward in the third, at the same time giving an indication of the amount of load being generated or "motored" by the apparent speed of the disk. Unless the motor were located in a comparatively dark place, and illuminated by an alternating arc lamp the effect would, of course, only be visible at night. Incandescent lamps do not cool sufficiently between alternations to give satisfactory results.

The illusion is, of course, not confined to motors and may be utilized for measuring the speed of any revolving mass if its speed does not vary too much from an even divisor of the normal rate. A rather amusing incident came under the writer's observation one evening in a shop illuminated by 60-cycle arc lamps. A man made several attempts to put a belt on a pulley which seemed to be revolving in a right-hand direction at about 350 revolutions per minute, but in reality was revolving about twice as fast in the opposite direction. Needless to say he failed to get the belt on; and when told the cause, promised to take the pledge, as he was sure he "had them bad."

An Overloaded Century Motor

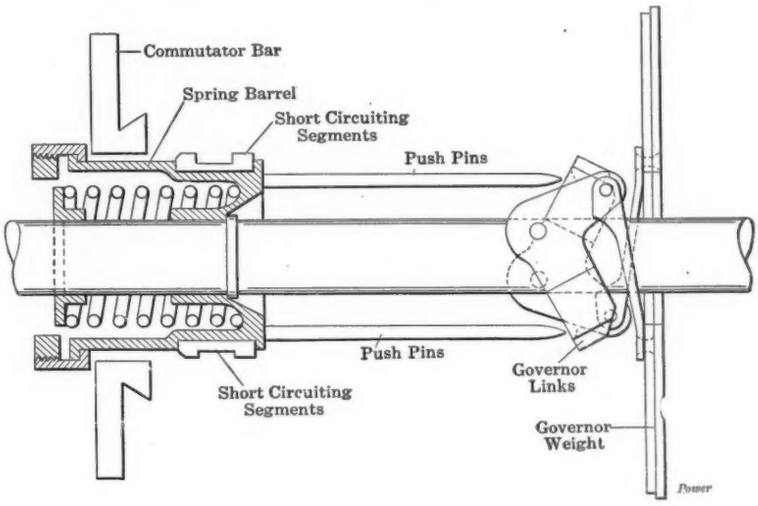
By H. T. Dean

The company with which I am connected has in service a large number of Wagner and Century single-phase motors of three and five horsepower, operating on a 110-volt circuit at 1750 revolutions per minute and 60 cycles and driving various machine tools. The performance of the motors has been satisfactory on all service except that imposed by a buffing wheel made up of a number of thicknesses of cotton cloth. This motor seemed to require more current than any other machine we had, and if the operator was not very careful when using the buffer the motor would slow up enough to let the governor drop the brushes back on the commutator, and would run that way until the job was done. A larger motor would not have done this, but the one we had did so invariably and difficulties arose from it.

After the motor had been doing this buffing work awhile it got weaker and weaker and finally quit altogether. When the switch was closed it would start all right and come up to speed, but the minute any load was put on it it would slow down. It finally got so bad that it would not come up to speed with no load; it would come to speed and then drop back; then come up again and so on. As all

the other motors on the line were doing all right, it was evidently a case of individual trouble with this particular one.

The connections were all good, the commutator in first-class shape and the brushes in good condition. The essential elements of the Century governor and brush mechanism are illustrated in the accompanying sketch. The operation is as follows: When the line switch is closed the motor starts more or less like a direct-current machine, but when it comes to its rated speed the governor weights fly out by centrifugal force and pull over links which push the plunger rods to the left; these force the spring barrel in the same direction, bringing the short-circuiting segments under the commutator segments and at the same time releasing the tension on the brush springs (not shown). The end play of the armature keeps the brushes off the commutator and centrifugal force holds the short-circuiting segments against the commutator segments, converting the motor into the equivalent of a squirrel-cage machine.



AUTOMATIC MECHANISM FOR SHORT-CIRCUITING ROTOR WINDING

Examination showed that the short-circuiting segments had arced from their upper faces to the commutator bars. These short-circuiting segments were merely copper punchings and the die that stamped them out was not very sharp, so the surfaces were quite rough. When the motor slowed up under the load a heavy current was flowing and, the centrifugal force being less than normal, the contact between the short-circuiting segments and the commutator bars was not very good; consequently there were produced minute arcs which pitted the surfaces and roughened them still more. This action was progressive until there was point contact only between the segments and the commutator bars. The area thus became too small to carry the current and more and more coils were cut out of the rotor, which resulted in the weakening of the armature. To overcome the difficulty, the faces of all the segments were sandpapered smooth, as were also the ends of the commutator bars. After it was reassembled the motor worked satisfactorily and has been doing so ever since.

We had trouble of a similar nature in the pattern shop. Here we find that fine wood dust collects in the sleeve and spoils the contact between the short-circuiting segments and the commutator bars; every two or three months we have to take the machine down and clean it out, after which it runs like a top until the dust gets thick again.

A word of caution might be given here about taking this type of machine apart. The tension on the spiral spring in the spring barrel is adjusted by the builders for the frequency of the current that the motor runs on and it will not run properly at any other tension. Therefore, when the nut holding the spring barrel is taken off, the number of turns to unscrew it should be counted and when it goes back it should be set in exactly the same place.

Simple Tests for Locating Faults in Circuits

BY W. T. RYAN

For determining very accurately the location of a fault in a circuit, especially in a cable, a galvanometer of the d'Arsonval type, a Wheatstone bridge and a battery are very useful. There are cable-testing sets made which comprise a Wheatstone bridge, a rheostat, battery, galvanometer and galvanometer keys, all mounted in a medium-sized carrying case, with complete directions for use. With such a set measurements can be made for electrostatic capacity, insulation resistance, crossed and grounded wires and the location of breaks in conductors.

A galvanometer, a Wheatstone bridge and a battery are required for making the tests which are described in this article.

SIMPLE GALVANOMETER TESTS

To identify a wire at any point in a conduit (or cable), ground the wires in question at one end of the conduit. Disconnect and keep insulated from each other all wires at both ends of the conduit. With a sharp-pointed needle connected to a galvanometer grounded through a battery, as in Fig. 1, make connection, by piercing the insulation, with each of the wires successively until the galvanometer shows a deflection; the wire thus identified is the one that is grounded at the other end of the conduit.

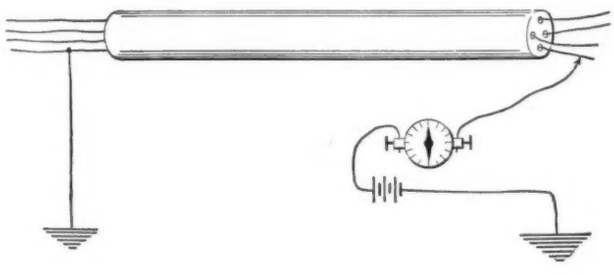


FIG. 1. TESTING FOR CONDUCTOR TERMINALS

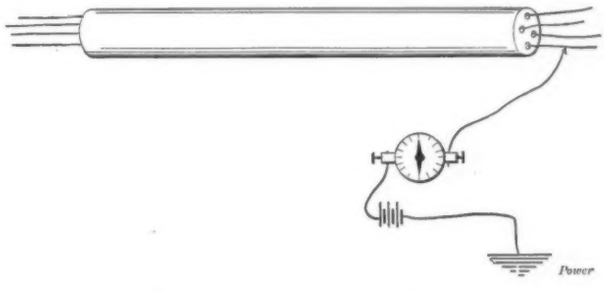


FIG. 2. TESTING FOR GROUNDED CONDUCTOR

To determine which wire in a conduit or cable is grounded, ground the galvanometer through the battery, as shown in Fig. 2, and make sure that all the wires at both ends are disconnected from each other and insulated. When the free terminal of the galvanometer is touched to the grounded wire it will cause the galvanometer to deflect.

To identify those wires in a conduit

which are crossed, attach the battery terminal to one wire, as at *A*, Fig. 3; then touch the other wires successively with the galvanometer terminal as at *B*. When a wire is touched which is crossed with the wire *A* the galvanometer will be deflected. If no deflection is obtained, the wire *A* is not crossed with any of the other wires. Mark this wire as "clear," connect the battery terminal to another wire, and test that one in the same way. Continue this until each wire has been tested with every other wire in the conduit.

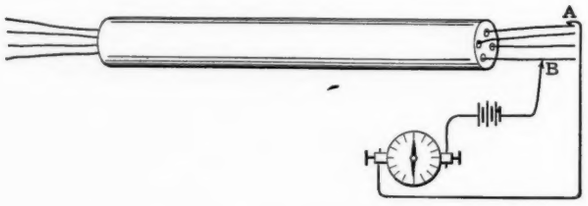


FIG. 3. TESTING FOR CROSSED CONDUCTORS

AN ELEMENTARY WHEATSTONE BRIDGE TEST

To identify the terminals of a wire when several of the wires in the conduit may be grounded, make the connections shown in Fig. 4, where *a* and *b* are the ends of a "clear" wire *W*, and *c* and *d* are two wire ends at opposite ends of the faulty conduit. All of the wires at the conduit ends must be kept insulated from each other. The resistance of the bridge arm *A* should be 1000 ohms and that of *B* 10 ohms. If the arm *R* can be adjusted so that the galvanometer shows no deflection when the key *K* is closed in either direction, then the ends *c* and *d* are the same wire; if not, they are different wires.

LETTERS

Mr. Greer's Synchronizing Connections

Referring to C. L. Greer's synchronizing connections discussed in the April 12 issue, I would criticize the suggested connections shown by his diagrams as follows:

In Fig. 2 the receptacles are connected in circuit with the primary winding of the main busbar synchronizing transformer and in the primary and secondary windings of each generator synchronizing transformer. If, by mistake, a generator ready to be synchronized should be plugged in on the synchronizing busbar when there was a plug already in on another running machine, a short-circuit would result on the 100-volt side of the generator transformers when the machines were opposite in phase, which would melt the fuses in the plugs and possibly cause the 400-volt side of the windings to flash over at the receptacles; in the latter case a short-circuit current would flow in the 400-volt windings through the 100-volt windings of the transformers. Mr. Greer has experienced this sort of trouble with his present connections.

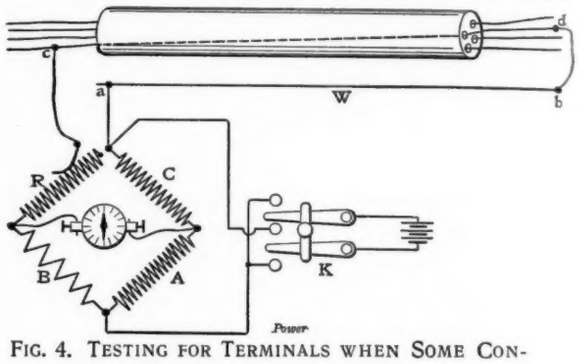


FIG. 4. TESTING FOR TERMINALS WHEN SOME CONDUCTORS ARE GROUNDED

It should be remembered that if the generators give 400 volts, effective e.m.f., the maximum voltage at the peak of the wave is in all probability about 560 volts. And when the machines are being synchronized, at the instant when their phases are in opposition there are 1120 volts between the two primary windings across the two receptacles.

Fig. 3 is better than Fig. 2 in that the 400-volt windings of the transformers on the generators are not connected to the receptacles. However, two plugs are still used in synchronizing and therefore the danger of a short-circuit on the 100-volt side, if two running machines are plugged in at the same time, still exists. No provision is made in either Fig. 2 or Fig. 3 for comparing the voltage of the generator being synchronized with the main busbar voltage.

The accompanying diagram of connections (Fig. 4) eliminates these objectionable features. Only one synchronizing plug is used in a four-point receptacle on any generator panel. Mr. Greer can use four points on each of the eight-point receptacles and one of the plugs which he now has in service.

Each machine and the main pair of busbars has its own potential transformer. The primary windings of these transformers are connected permanently to their source of current and take but a small fraction of an ampere.

The receptacles are connected in circuit with the secondaries only of the transformers. A voltmeter controlled by

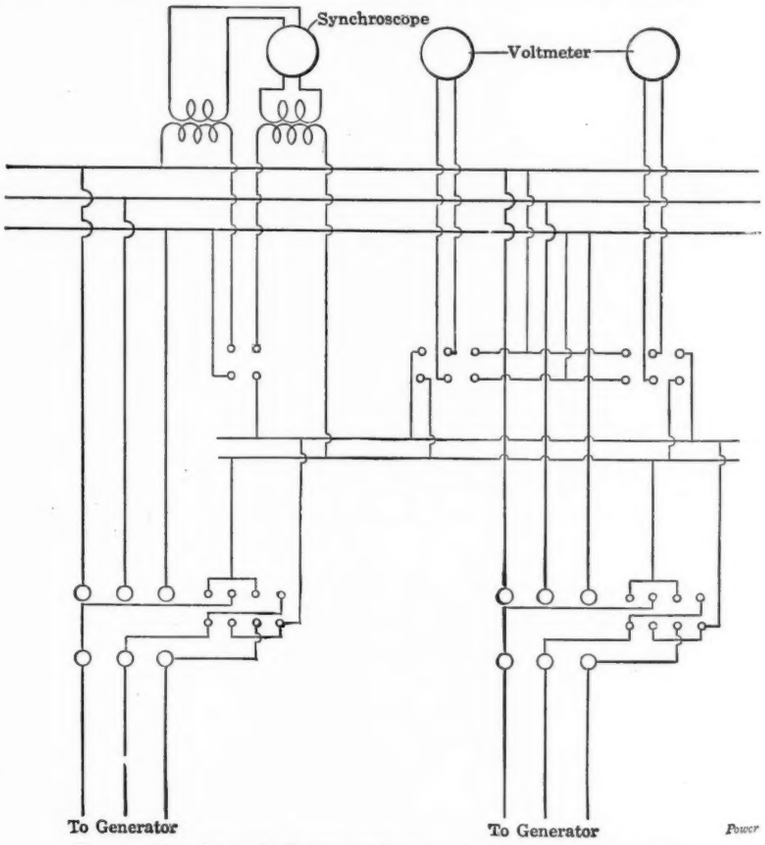


FIG. 1. MR. GREER'S PRESENT SYNCHRONIZING CONNECTIONS

the synchronizing plug indicates the voltage on the generator being synchronized, and the voltage of the main busbars is indicated at all times by a voltmeter connected permanently to the secondary terminals of the busbar transformer.

Connections similar to these are in satisfactory use in one of the large power stations of the country.

F. H. COBLE.

Baltimore, Md.

Referring to Mr. Greer's problem in synchronizing connections, it will be noted that the synchronizing busbars can be connected to any of the three phases through an eight-point plug switch, which, while not necessary for paralleling, permits the voltage to be read on any phase by means of a voltmeter connected to the synchronizing busbars. This arrangement complicates the wiring and it does not seem necessary to provide for voltage readings on all phases of each machine, as one eight-point receptacle connected to the busbars would give the reading on any phase of the system irrespective of which machine was running. I would suggest connecting one phase of each machine to the synchronizing busbars through a double-pole plug switch and connecting to the same busbars a single-potential transformer which would reduce the voltage for the synchroscope. A similar transformer connecting to the corresponding phase of the main busbars would have its secondary connected through a double-pole plug switch to the busbar side of the synchroscope. With properly designed plugs and receptacles there should be no trouble from flashing over when removing the plug, and by using but one phase there will be no chance of plugging two different phases together as at present. A voltmeter across the synchronizing busbars would, by inserting the machine synchronizing plug, give the machine voltage on one phase and allow it to be adjusted to that of the main busbars.

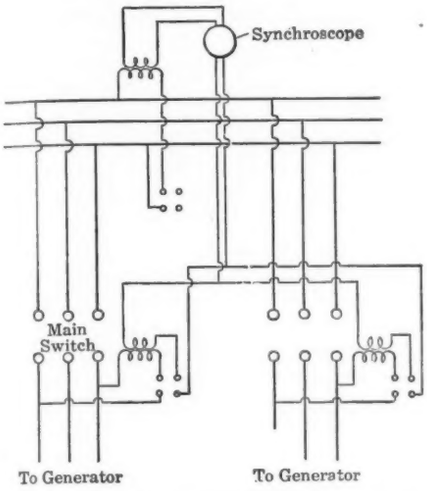


FIG. 2 MR. GREER'S PROPOSED SYNCHRONIZING CONNECTIONS

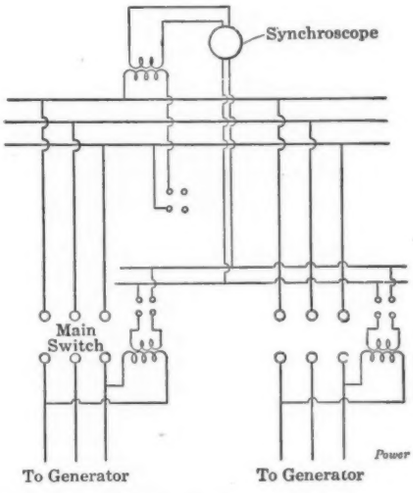


FIG. 3

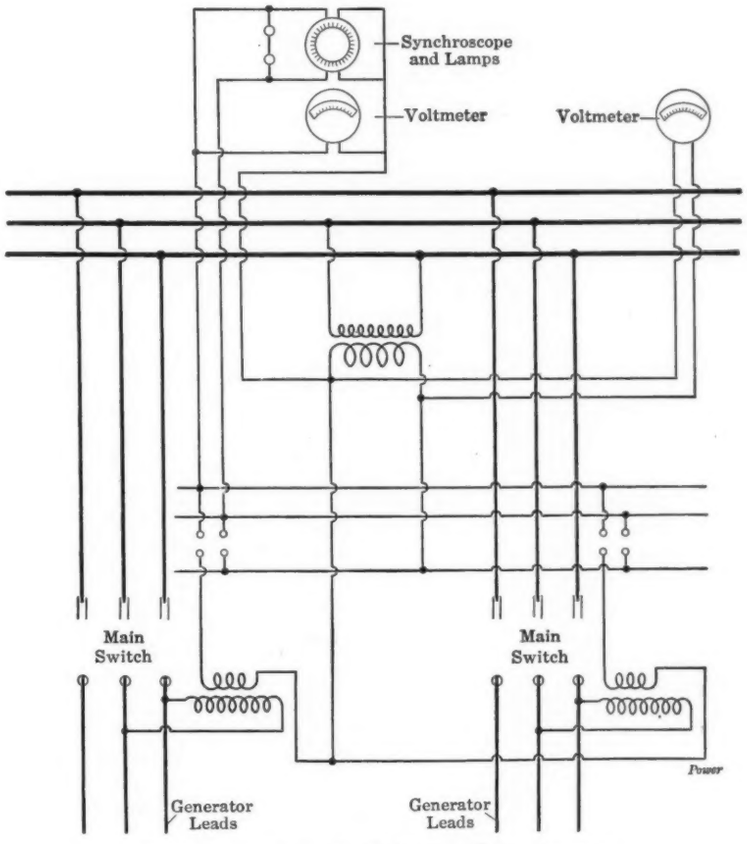


FIG. 4. MR. COBLE'S PROPOSED CONNECTIONS

It is customary to fuse the synchronizing connections where they leave the main busbars and the machine leads, as a short-circuit is very likely to occur in the synchronizing connections. The plug is an unsuitable place to install a fuse and I always remove them and put in copper wire.

In Mr. Greer's diagram the holes in the eight-point receptacle seem to be the same distance apart both horizontally and vertically, which would permit the plug to be inserted to make the connection horizontally instead of vertically and cause a bad short-circuit. With two similar plugs there is always a chance of plugging two machines to the synchronizing busbars at the same time, thereby causing a short-circuit. The remedy would be to have but one machine plug, as only one can be used at a time, and to have the spacing different on the busbar synchronizing plug from that of the machine plug, so that it would not be possible to use it on a machine panel when the machine plug was on another panel.

I am assuming that the voltage in the present instance does not exceed 500, in which case transformers would be unnecessary except for reducing the voltage for the synchroscope. I would also suggest synchronizing lamps to serve as a check on the synchroscope, which might stick or stop working and give a false indication. I have found the synchroscope erratic when the machines were far out of step, and that the lamps give more reliable indications until the machines come nearer synchronism. The lamps would shunt around the synchroscope from the machine to the busbar side on the same leg. One can be on the board and the other in the engine room if desired. I would favor the connection shown in Fig. 3, omitting the transformers on the machine leads.

LEWIS C. REYNOLDS.

Willard, N. Y.

Gas Power Department

Mr. Ellison Elucidates

[We recently published an abstract of an address delivered by Lewis M. Ellison and commented on the address editorially on page 783, April 26. Mr. Ellison sent us a reply to the editorial with the request that it be published exactly as he wrote it. Below is the reply, *verbatim*—EDITOR.]

POWER PLANT ECONOMICS AND CORRECTED MISREPRESENTATIONS

BY LEWIS M. ELLISON

Everything worth while in the gas engine and producer industry will be treated here in a way that can be of use to practical men.

1. Having been misrepresented in the report of my lecture on "Troubles I have located in Steam Plants" April 6 before N. A. S. E. No. 1 of Chicago in the April 26 issue of your paper, under the heading of "Steam Engine in no Danger from Gas Engine," presumably through error in not reporting correctly my statements, and the figures on the black board, and having been unmercifully ridiculed in relation thereto in an editorial article in the same issue, by answering that singing editorial should suffice also in correcting the serious errors in the report, and also in furnishing the necessary information in regard to conditions stipulated, some of which make vast differences in some of the results, all of which, I believe, should make my contentions clear and logical.

2. First let us have it understood at the outset, that I am not an absurdly partisan, or any other kind of partisan, to the steam engine, steam turbine, gas engine, or to any other apparatus or device whatsoever.

3. The steam engine, steam turbine and gas engine, all have their place. It is a fine combination, a sort of tripod, one in a measure inseparable from the other two.

4. The selection of plant best adapted to a given set of conditions is an economic problem that should be dealt with as engineers ought to deal with such problems.

5. Second let us have it understood, that the place for these prime movers was clearly defined, and that the gas engine was given all the credit it justly deserved, and no more.

6. As to my stating that the fuel economy of steam power would never be superseded by gas power, no such statement was made. Gas power was not compared with steam power without qualifying the kind of gas and steam power plants, the locality and conditions; and, furthermore, I have no way of knowing what the relative performance of the two powers may be in a hundred or a thousand years from now.

7. If you cannot agree with me that a modern steam equipment, composed of compound condensing engines of 165 pounds initial steam pressure, and water tube boilers fitted with mechanical stokers, burning a low grade of bituminous coal, such as is ordinarily burned in such installations in the bituminous coal district, cannot anywhere except at the coal mines, develop an indicated horsepower for less than one-fifth of a cent (0.18 stated) then what is the lowest fuel cost?

8. Not only can an indicated horsepower be developed for 0.18 of a cent, but for less; and with 185 pounds, the more preferable and about the highest present operating steam pressure in stationary plants, for 0.12 of a cent, and in some localities for less.

9. The pressure of 185 pounds is not nearly high enough, and when the pressure is brought up to the requirements of the times, and the engines built accordingly, and as engines ought to be built, the coal cost for a given output will be considerably less than in that of the present modern coal gas producer-engine plant.

10. As to my putting a gas producer-engine horsepower at 1.5 cents per hour, no such absurd statement was made. Anyone having such opinion must be ignorant of gas producer-engine performance.

11. The figure given was 15 per cent. as the combined thermal efficiency per brake horsepower of a bituminous coal gas producer-engine plant, based on the producer having an average efficiency of about 65 per cent. when using a low grade of bituminous coal and operated in the hands of the average man, and the engine based on using an average of about 11,000 B.t.u. per brake horsepower, with engine in fairly good condition and in regular service.

12. If you do not know of any plant, distant from a coal mine, in which a thousand pounds of water are evaporated for 12 cents' worth of coal, then what is the lowest cost you know of?

13. Not only can a thousand pounds of water be evaporated for 12 cents' worth of coal in the loop district of Chicago, but in the greater portion of the state of Illinois, and in states north, south, east and west of Illinois, the greatest steam power producing district in the world, and in states so far south as the Gulf of Mexico; not only for 12 cents, but in a large portion of the entire bituminous coal district for 10 cents, and in quite a number of localities for just a little less, none of which are at the coal shaft.

14. As to my stating that 12 cents is the outside cost in the loop district of Chicago, that is incorrect. It was stated that about 10 years ago, in the average hand fired furnace plant in the loop district, burning the better grades of coal, some semi-bituminous, the cost was from about 12 to about 16 cents, and that the present cost for the same quality of coal in the same type of furnaces would be higher in proportion to the advance in the price of such fuel, but that a large number of the plants tested, and from which the data was collected, had since installed mechanical stokers and were burning a cheaper grade of coal.

15. As to my putting the gas producer efficiency at 65 per cent, that was for a bituminous coal gas producer, under the conditions referred to. If you do not agree with me on this efficiency, under the conditions stipulated, then what is the efficiency under such conditions?

16. As to my putting the gas engine efficiency at 23 per cent, it was stated that ordinarily the gas consumption ranged from about 10,000 to about 11,000 B.t.u. per brake horsepower, and that 11,000 could be considered reasonably good average performance in regular service, an efficiency per brake horsepower of 23.1 per cent; that a number of gas engines under favorable conditions would develop a brake horsepower on 10,000 B.t.u., an efficiency of 25.5 per cent; and that a brake horsepower could be developed on about 9,500 B.t.u., an efficiency of 26.8 per cent. What is wrong, if anything, about this?

17. If there are any thermodynamic obscurities in connection with the subject, they have not been furnished by me.

18. To deal merely with plain, common lumps of coal and engine-shaft power, as you state, is not the proper method of dealing with fuel cost; and here, we clash again.

19. Not even the average house wife will be content to deal with the consideration of lumps of coal and sputtering grease at the kitchen stove.

20. Most of us, I believe, have a reasonably fair conception of the meaning of B.t.u.'s, and need not altogether deal

with lumps of coal in a bushel basket.

21. Fuel economists, and engineers of the right kind, do not figure power plant economics that way. The man that puts up the cream of tartar for the coal pile wants the fuel cost at the engine shaft, or better still, the power cost at the point of delivery, in dollars and cents, not in lumps of coal.

22. Now about that 1¼ pounds of pea coal per brake horsepower-hour in a good producer and engine of 500 horsepower as you state. To take out our steam plants in the bituminous coal district, advantageously located, and put in gas producer-engine plants to the extent some gas engine radicals propose, and "import" pea coal, for which the demand would ultimately exceed the visible supply, if for no other reason, is a proposition I do not advocate, at the present stage of the game. Would you?

23. As to how many steam plants of 1000 horsepower or under are developing or can develop a brake horsepower on 1½ pounds of bituminous coal, or anything like it, I must confess I do not know, nor do I know of anyone that could furnish this information.

24. Quite a number could, not only on 1½ pounds, but on even a less quantity, if they cared to burn the better grades at the expense of the credit side of the engineer's log.

25. Such grades we usually leave to the struggling fellow having inadequate boiler capacity, and who must keep the wheels turning at any cost.

26. Some to the popular fellow whose plant is located in a neighborhood where the smoke abatement law is rigidly enforced, who has not top notches of smokeless furnaces that can burn anything and everything in any old way without smoke, patented in the United States and all foreign countries, of the kind that all infringers will be vigorously prosecuted to the full extent of the law, and where the engineer is jerked up into the courts of law, and a heavy fine imposed, for immitting objectionable smoke when the smoke inspector happened to be on watch.

27. And some to the lonely fellow, whose plant is distant from a coal mine, very distant, where the freight rates are high, and where there are no more freight rebates, for sure.

28. For relative fuel costs, we should compare a modern steam plant with a modern gas producer-engine plant, and not the latter with the average steam plant, most of which are a lot of old junk and ought to be thrown out.

29. We might as well match a sturdy and efficient pugulist with a weakling, not versed in the arts and sciences of such a dignified [?] vocation.

30. In the bituminous coal district we should compare the relative fuel costs in such installations, both using the same grade and price of bituminous coal, or each a grade best adapted to its own individual conditions and requirements, and of the kinds the plants in the vicinity are using. Or better still, the power cost, including such things as reliability of service, and a few other things, the plant owner would like to know about.

31. For the district mentioned, and for the present, a modern steam plant is the better proposition.

32. I have stated some of the evaporation and fuel costs in steam plants in the bituminous coal district; now tell us, Mr. Editor, as much as you feel disposed, about the fuel cost of a modern bituminous gas-producer-engine plant.

33. As to my stating that the overall efficiency of the present gas-power plant does not equal that which will ultimately be realized by the steam plant of the future, I must repeat that no such statement was made, for the reasons already given.

34. Your stating that my optimism lead me beyond the limits of logic, my reply on this point do not so indicate.

35. As to your stating that in the very nature of things, a steam plant of ordinary size cannot be expected to compete with a gas-power plant in fuel economy, that would be a very indefinite expression. There is not anything tangible about such a statement. If you refer to the power from the conversion of the available heat energy into external work of existing gases, such as natural gas or waste gases, for instance, the gas engine can't be beat.

36. What would be the use of having a steam plant and having to suffer the boiler loss, when we can shoot the stuff into the gas engine cylinder direct, and get a few swift kicks?

37. For certain fuels, in certain localities, and for certain purposes, the gas engine fits in fine.

38. Under the circumstances, there was nothing irrelevant about my referring to the consideration of gas engines operating on Chicago illuminating gas. First, because we have a good many hundred small sizes so operated, and for certain places are all right.

39. We also have quite a number operating on "natural" gas, the more economical gas, costing 50 cents per 1000 cubic feet, the supply of which is limited and to a certain portion of the city.

40. On basis of this gas having an average net heat value of 910 B.t.u. per cubic foot, and the engine using 11,000 B.t.u. per brake horsepower-hour, the gas consumption would be $11{,}000 \div 910 = 12.1$ cubic feet, and,

$$\frac{12.1 \times 50c}{1000} = 0.61$$

of a cent per brake horsepower-hour.

41. This fuel cost compares favorably with the average non-condensing steam plant having short stroke, high speed engines, and hand fired common furnaces. For small size engines, and for certain purposes, no fault should be found with this cost, but it should not be misrepresented, that is one way of killing even good things.

42. Second, because, Chicago is also blessed with having a few gas engine radicals, who even advocate the replacing of out steam plants with such gas power plants, and tell us that unless the operating stationary engineers study up on gas engines (mighty quick too) they will all be out of jobs.

43. For those who do not care for corporation gas, or about new fields of research, and start life anew, there may be some comfort in seeing the comparative fuel costs of a Chicago modern steam plant and of a Chicago proposed "monumental exception" plant.

CORRESPONDENCE

Water and Oil in the Crank Case

In the Gas Power Department of the April 5 issue, Mr. Booth suggests using part water in the crank case to decrease the amount of oil necessary to fill it. This seems to be quite common practice in stationary work with slow-speed engines having large chambers in the bases to be filled with oil, but I once had a great deal of trouble with a 100-horsepower marine engine which I was operating, due to water in the crank case. At the higher speeds used in marine work, the oil is churned up more than in a stationary engine and seemed to form a sort of vaseline or jelly if there was the least water present. This was worse than useless for lubrication purposes and caused the bearings to heat up badly 10 or 15 minutes after starting. If any water found its way into the oil in the base, the oil would become thick within two or three days, even if there was not more than a few teaspoonfuls. In the absence of water, the oil would run for five or six weeks without getting dirty, so that the trouble was not due to the carbon from the decomposed oil.

EDGAR H. MOSHER.

New York City.

Whom Did He Mean?

Some of you may remember the dark ages of the cotton industry when "trade secrets" were still the vogue. In not a few cases, there was presented the same absurd spectacle as is to be seen today in some other industries—the spectacle of each manufacturer carefully guarding a "secret" that most of the others possess.—Extract from a recent address.

Readers with Something to Say

Practical information from the man on the job. A letter good enough to print here will be paid for. Ideas, not mere words, wanted.

Consuming Smoke

Some time ago the Boston daily papers agitated a more rigid enforcement of the anti-smoke laws. In consequence, the inspectors became so active that manufacturers of anything bearing the name "Smoke Consumer" found but little difficulty in persuading boiler owners to purchase their wares. I recall two poor specimens of such devices which were

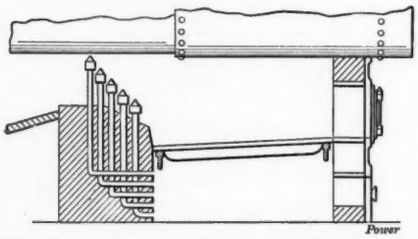


FIG. 1. SCHEME WHICH DID NOT WORK.

installed under two 54-inch boilers. Their general appearance and construction are shown in Fig. 1. They consisted of a bank of ¾-inch pipes, bent at right angles, and set in the bridgewall, in such a manner as to allow some of the air from the ashpit to enter the pipes, and emanate through the perforated nozzles, the object being to supply heated air to aid combustion. It was claimed that the air passing through would prevent the pipes becoming overheated, but unfortunately there was nothing to prevent the perforations from clogging with coal and ashes, which happened in a remarkably short time, limiting the usefulness of the consumer to about four months.

The engineer in charge endeavored to improve the arrangement by supplying the pipes with forced draft. The bridgewall was made hollow, and the output of a small Sturtevant fan was forced into

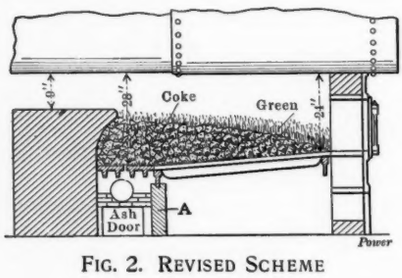


FIG. 2. REVISED SCHEME

the chamber. The current pressure was sufficient to maintain the nozzle holes clear, and the quantity of air that passed was sufficient to prevent too rapid deterioration of the pipes. But the boilers did not steam so well; fires needed more frequent attention, and it was evident that more coal was being burned. A carbon-dioxide recorder was obtained and several samples of the flue gases were analyzed, the results showing that with the consumer in service, the temperature of the flue gases was much lower than when the fan was stopped, but the percentage of carbon dioxide present proved to be very low. This showed conclusively that a low flue temperature is no indication of high boiler efficiency.

The discovery led to the abandonment of the forced-draft air pipes, and the design of furnace shown in Fig. 2 was evolved. It will be seen that the grate area was enlarged by the addition of two grate bars, placed crosswise of the furnace, these having an ashpit of their

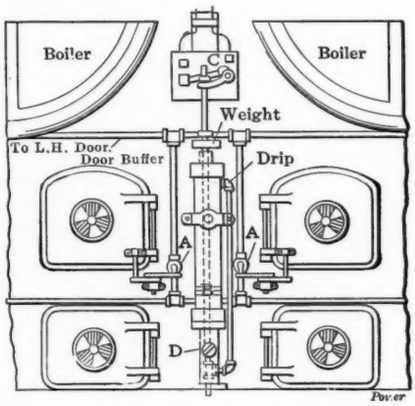


FIG. 3. ATTACHMENTS ON FURNACE DOORS

own separated from the regular pit by the 6-inch wall *A*. To the right of this, the fire is subject to natural draft; to the left, the output from a fan is intermittently delivered. The grates are 4 inches lower at the back than at the front, which allows a large bed of coke near the bridgewall. The fan motor is wired so as to automatically start and run for about three minutes after each coaling up. Therefore the bed of coke lying on the two crossbars is not consumed to any great extent, and the boiler is obliged to carry the load with the original grate surface and natural draft. The coke in the back end, however, is always in a state ready to be fanned into incandescence, and when necessary a roaring fire can be quickly obtained, by simply starting the motor. The method of firing does not differ from that of the ordinary furnace, though it is preferable to levelling the fire as shown in the illustration.

The manner in which the motor is operated is shown in Fig. 3. Opening one or other of the furnace doors opens slightly the water cock *A*, which admits water under pressure below the piston *B*, causing it to slowly rise. The piston rod connects with the snap switch *C*, which makes or breaks the circuit to the motor. The opening of the cock *A* is so adjusted that it takes about ten seconds for the piston to rise to a hight sufficient to snap the switch and start the motor, which allows ample time to inspect the fires. The drain cock *D* is so set that it takes about three minutes for the piston to lower sufficiently to open the circuit. To prevent clinkers from clinging to the bridgewall, a piece of 3-inch pipe is rolled into the angle formed by the two grates, and the bar allowed to slide over this.

K. P. EVERETTE.

Boston, Mass.

New York State Boiler Inspection

The "factory inspection laws" of the State of New York make it compulsatory for all owners or operators of manufacturing plants where steam is used, to have the boiler or boilers examined semi-annually by a competent boiler inspector. The report of such inspections must be forwarded to the proper authorities in Albany and placed on record. This law is a good one if properly enforced.

Probably 80 per cent. of the boilers in use in this State are insured and regularly inspected by the insurance companies' inspectors. This complies with the law and protects the owner or operator in case of accident, for such an amount as the policy of insurance calls for. This also guarantees thorough inspections, the cost of which is so small considering the risk taken, and the inspections are so much more thorough than those given by the local boilermaker, that a manufacturer or operator who does not insure his boilers stands in his own light.

In one of the largest cities in New York State the board of education advertised for bids for boiler insurance on about sixty boilers. This amounted to about $75,000. They specified that the bid must state the length of time the inspectors, who were to do the work, had been in the employ of the insurance company and their total years of experience as boiler inspectors. In that same city men are sent out from local boiler and machine shops, to inspect steam boil-

ers, who do not know how to figure the strength of a seam, the shear of a rivet or the strength of a brace. They know nothing whatever of the workings of any of the many appliances and fittings of the boilers they are inspecting, although they could put on a patch, calk a leak or put in a tube. Any one of the janitors could make a more detailed boiler-inspection report than such local inspectors, for the reason that they have posted themselves on boiler matters before passing their civil-service examinations.

The local boilermaker, machinist or steamfitter cannot be blamed for doing this work; his employer sends him and he is doing the best he can. Very often these inspections are made by request of an insurance company's local agent, so as to hold his business until the regular inspector reaches the territory. These inspections are satisfactory to the factory-inspection department, but are very unsatisfactory to competent engineers.

The following question often arises among engineers: "Why does New York, the greatest State in the Union, accept such inspections, and why does the owner or operator of a plant allow them?" The owner has to pay for them, but does not in any way receive benefit or even useful advice from such inspections except that he has complied with the State factory-inspection law. But the engineers should ask themselves why they allow it when they know the inspections are not thorough and not done as well as they do it themselves when their boilers are emptied for cleaning. This is a subject that has been brought up in several associations, and it is one that owners, operators and engineers of steam plants should take considerable interest in. If they would do so, the present farce of so called boiler inspection would be a thing of the past.

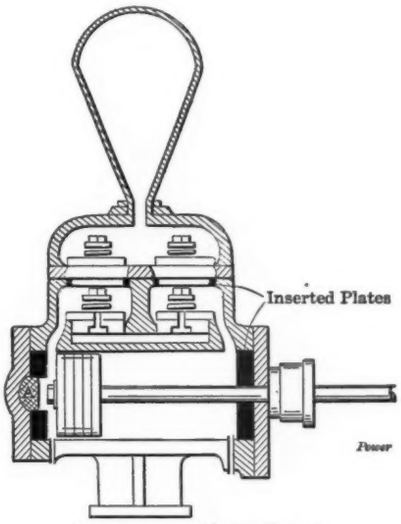
New York State is slow to enact a State license law for engineers. For years the engineers have been trying to have a State law passed, but for some reason they have never worked together and the result has been failure; but now engineers all over the State should join heartily in advocating the license law which is before the legislature. They have been working for it for years, and there never has been a better chance for its enactment than at present. It is not in the interest of any one class or organization and is of equal interest to the employer and the engineer. I would like to see every reader of POWER in this State take the matter up with his assemblyman or State senator, requesting them to vote favorably when the matter comes before them. Why should New York be behind Massachusetts or Ohio in so important a matter as an engineers' State license law?

W. R. JANTON.

Rochester, N. Y.

Pump Troubles

A certain engineer of my acquaintance delights in showing a pump which he claims was bought from the makers for half price. The lift of this pump is 27 feet. When it was first installed it absolutely refused to deliver any water. The manufacturers, who had guaranteed the pump, were called in, and various methods were resorted to in an effort to make the pump work, but without avail. Finally, the makers cut half off the price



SECTION THROUGH PUMP

of the pump in consideration of the fact that a pit would have to be dug, and the pump placed therein, to shorten the hight of the suction pipe. But the pump still stands on the original foundation, and apparently is freely delivering all the water required, the engineer having overcome the difficulty by fitting plates at each end of the water cylinder as shown by the darkened sections in the drawing. The clearance space was thus reduced and the pump enabled to compress and exhaust the air sufficiently to create the required vacuum. A heavy rubber bumper was also fitted into the plate at *A* to relieve the shock of the nuts when starting the pump.

R. O. RICHARDS.

Framingham, Mass.

Large Losses from Small Leaks

It is surprising what a great loss an apparently small leak will cause in an engine and how truthful the indicator is in locating it. Our large pumping engine is of the triple-expansion type, carrying 15-inch piston valves and governed by a pendulum governor operating on a steam piston. This controlled the rocker shaft, moving the blocks in half links, carried by two eccentrics, and thereby graduating the travel of the valve and giving automatic cutoff. It pumped directly against the ram of a 52-inch hydraulic press, operated by hand valves; the hydraulic line relieving at 10,000 pounds pressure.

A short time ago the excessive steam consumption of this engine became quite apparent by the extra demand upon the boilers, and it was decided to take an indicator diagram in an endeavor to locate

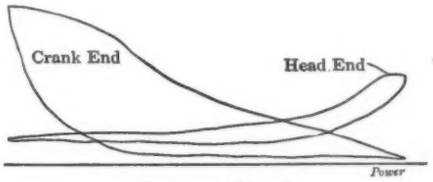


DIAGRAM NO. 1

the trouble. It was a difficult matter to obtain a load constant enough to catch both strokes with one indicator, there being no flexibility to hydraulic pressure.

Diagram No. 1 shows on the head end, a loss of compression, failure to build up during admission, holding up of the expansion line, and a very definite back pressure during exhaust. All these points indicate a leak past the head end of the valve, as a leaky piston would have affected both ends.

The valve was taken out and an examination showed a leak due to wear; it being about 0.015 inch in the worst place.

It hardly seemed credible that this leak could have caused such a bad diagram, but after expanding the valve and truing up the bushing in the steam chest, diagram No. 2 was taken with the governor connected up and the engine carrying normal load. This showed a decided improvement, and as the wear on the valve and bushing was due to the weight of the former, it was decided to extend the head

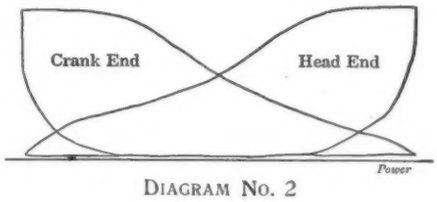


DIAGRAM NO. 2

end of the valve rod through the steam-chest cap and put on a shoe and guide to carry the weight of the valve.

The saving in steam consumption plainly showed the value of the indicator in locating such trouble.

P. W. WILLIAMS.

Philadelphia, Penn.

Oiling Systems

In engine rooms, containing two or more engines, an oiling system, properly designed and installed, is economical as well as convenient. A proper oiling system will filter the oil coming from the engine and return it to the engine, the operation being continuous, and requiring but little attention.

The system must, of course, be planned to meet the requirements of each case, and can be divided into two general classes, viz., forced feed and gravity.

While forced-feed lubrication may be preferred or even necessary in some cases, the gravity method will give better satisfaction, in most cases, when applied to stationary plants. In both systems a pressure is maintained at the feeds.

In the forced-feed system this pressure is secured from the pump direct, the speed of the pump being automatically controlled by the pressure on the system, or the pressure may be controlled by a relief valve, connected to the pump discharge, through which the surplus oil may be bypassed to the suction side.

It is obvious that a failure of the pump will immediately interrupt lubrication throughout the system, and even if another pump were available, the failure

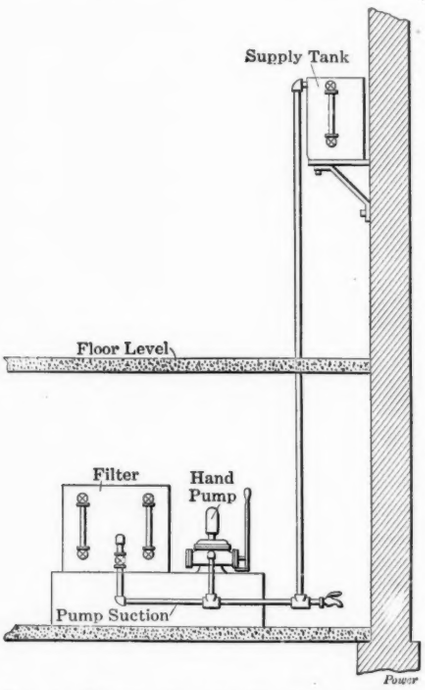


FIG. 1. FILTER, SUPPLY TANK AND HAND PUMP

of the attendant to notice the interruption at once might result in serious trouble.

In the gravity system, a supply tank is installed at a proper elevation to secure the desired head. The capacity of this tank should be sufficient to tide over any derangement of the pump, short of a breakdown, the possibility of which would be remote in a case of this kind. Even this possibility could be provided for at small extra cost, by having a hand pump conveniently connected, as in Fig. 1.

Where there is a basement under the engine room the problem of installing an oiling system is somewhat simplified. The filter may then be placed in the basement, the oil from the bearings draining directly to it by gravity. The pump would then force the filtered oil to the overhead supply tank. In Fig. 2 is shown, in a general way, the installation of the filter, pump and supply tank.

An arrangement for taking care of the drain oil in a plant without a basement is shown in Fig. 3. Here the filter is

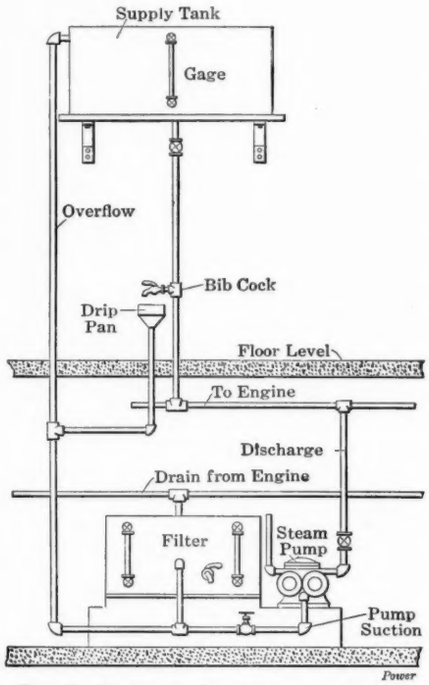


FIG. 2. GENERAL ARRANGEMENT OF OIL SYSTEM

elevated to be used in lieu of a storage tank.

The drain tank must be set low enough to allow the oil from the bearings to gravitate to it. In the figure, it is shown set in a pit constructed for the purpose. The pump may be placed in the pit, or above the floor as shown. It would be

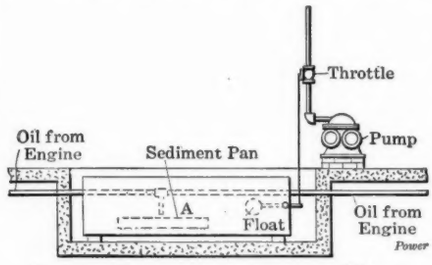


FIG. 3. FILTER ARRANGEMENT WHEN PLANT HAS NO BASEMENT

desirable, under these conditions, to regulate the speed of the pump, for the reason that were an overflow used, the clean oil overflowing would again be passed through the filter without doing any work. This would impair the efficiency of the filter to a degree, depending on its capacity and the amount of overflow. The pump regulator referred to could be obtained by using a float in the drain tank, in connection with the pump throttle, as shown. In the drain tank is a shallow sediment pan *A*, into which the drain discharges. This pan acts as a catch basin for the heavier matter contained in the oil and can be easily lifted out for cleaning as often as required. Should it be desired to heat the contents of the drain tank, a pipe coil could be placed in it and the pump exhaust passed through it. Most filters have coils for this purpose.

J. B. CLAPP.

Cleveland, O.

Raising Feed Water Temperature

Several months ago I experienced considerable trouble with low feed-water temperatures. Our plant consists of three 325-horsepower Heine boilers, one 500-kilowatt and another 325-kilowatt generator direct-connected to Corliss engines, and one Cochran open heater rated at 500 horsepower. The plant is run noncondensing and the heater is connected in the usual way.

It was the practice to run the 325-kilowatt set from about midnight to 4 or 5 p.m. the following afternoon with a load ranging from 50 to 150 kilowatts.

During this time we usually obtained a feed-water temperature of 140 to 208 degrees. If the load was light and remained steady, a temperature of 206 or 208 degrees could be maintained, provided the feed pump was so regulated as not to require adjusting. If, for any reason the pump was speeded up, the temperature of the feed water was sure to fall. After starting the 500-kilowatt set it was impossible to get a temperature of more than 190 degrees and more often it was considerably below this, ranging from 110 to 170 degrees, until the load went off. During the day we ran on one boiler until late in the afternoon when another was cut in for the peak of the load. From the above it will be noticed that when the load was heaviest and hot feed water would have been desirable, it was hardest to obtain.

Upon examination I found that when the water was at its lowest temperature the vent pipe from the heater was cold. I proceeded to the roof and found that a strong current of cold air was being sucked down into the heater through the vent. After second thought, this did not seem unnatural as I knew that when exhaust steam went into the heater and was condensed, a partial vacuum was formed, hence the flow of air. By placing my hand over the vent and allowing it to bob up and down, it was soon burned by exhaust steam. The action of this was as follows:

Upon exhausting from the engine, the steam went into the heater and was condensed by the cold water, thus creating a partial vacuum, as before stated. But before the engine had time to exhaust again, cold air rushed down the vent and into the heater, not only cooling

what had just been heated, but by the time the next exhaust took place, the pressure in the heater was about equal to that of the atmosphere and the bulk of the exhaust choosing the path of least resistance, escaped to the atmosphere through the exhaust pipe. The result was that only a small amount passed through the heater to heat the feed water; hence cold feed water was obtained while the boilers were steaming rapidly.

This led to the placing of a check valve, made from a piece of sheet iron and wire, on top of the vent pipe. By this means, all cold air is kept out and a vacuum maintained in the heater. Any surplus exhaust that is drawn in and not condensed, or any air that may come in the feed water is allowed to escape.

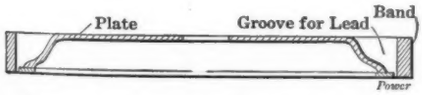
Since adding this check to our heater, an almost constant temperature of 206 degrees in the feed water is maintained regardless of changes in load. Occasionally 208 degrees is reached, and never less than 204 degrees. The variation of the feed pump to suit the load does not affect the temperature of the water. It might be well to remark that we can now carry over the peak of the load without the assistance of the other boiler. It is obvious that this gain in feed-water temperature results in a decided saving in coal.

C. A. Russ.

Hattiesburg, Miss.

The Use of Lead Gaskets

Some years ago, the writer was confronted by a rather expensive gasket proposition. The company had two plants located near to each other, one equipped with five Atlas boilers, and the other with four Erie return-tubular boilers of 150 horsepower each.



Method of Attaching Lead Gasket

Our feed water was taken from a stream upon the banks of which the power house stood. Naturally there was much trouble with mud, and despite the provisions used to guard against it, we were never able to run a boiler over two weeks without cleaning. The replacing of manhole gaskets was therefore found to be a rather expensive affair, as we never had much success in using a gasket that had seen service before.

To overcome this difficulty a plan was resorted to, which proved both successful and inexpensive. It was the use of homemade lead gaskets. When the manhole plates were removed for the purpose of cleaning a boiler, we had the blacksmith shrink a band about 2 inches wide and ½ inch thick around the rims in such a way as to make a groove in the space to be occupied by the gasket (See the accompanying illustration). The plate would then be leveled and molten lead run into the groove, filling it up near to the shoulder of the plate proper. The flanges of the manholes were simply the lead plate rolled inward in the usual way.

The gaskets made in this way usually lasted for about five or six removals of the plate, after which they were cut out and fresh lead added.

E. T. Binns.

Philadelphia, Penn.

A Reconstructed Heater

Having had considerable trouble with a water heater of a common type I will relate the method I used in overcoming this trouble, hoping my experience may be of use to others in similar cases.

The heater in question is of the horizontal, flat-coil type, 13 feet long by 29 inches in diameter, and is used to heat the water in several buildings. The temperature is controlled by a thermostatic regulator which closes a diaphragm valve in the steam line when the temperature reaches 180 degrees. The heater contains two coils of 3-inch brass pipe, each coil being made up of five 12-foot lengths with the necessary return bends. The coils are so connected that both may be used on either live or exhaust steam or one on each at the same time. The trouble has been to keep the joints tight, where the colls come through the heads; also to keep the joints at the return bends from leaking. For when they do, the coils fill with water and this leads to a bad water hammer when steam is turned on, to say nothing of the great waste of both heat and water.

By referring to Fig. 1, which is a plan view of the heater before any changes were made, it will be seen that the coils pass through both heads and are made tight at these points by locknuts and wicking. Brass having nearly double the expansion of iron, there were times when these coils were under considerable strain, causing the joints at the heads to leak, and in time the joints at the return bends also began to leak and give trouble.

About two years ago I overhauled this heater and made all joints tight, but in less than a year it began to give trouble again, and about two months ago almost entirely gave out. I had about made up my mind as to where the trouble was located and proceeded to remodel the heater according to a plan of my own. Fig. 2 shows a plan view of the heater as it is now. I substituted 2½-inch pipe for the old 3-inch and used six pipes instead of five, thus bringing both ends of each coil out at the same head and leaving one end of the coil free to move, thereby relieving the joints of most of the strain due to expansion. As the heads of this heater are bumpted it became necessary to provide four flat places in one head in order to make up the joints at the places where the coil ends came through. As it promised to be a difficult matter to make provision for this by driving the head in, I had two castings *A*, Fig. 2, made to conform to the shape of the head, each having two 3⅛-inch holes which were extended by bosses on each side. These castings were riveted to the front head, and had a calking strip inserted between the casting and the head, after which the bosses were dressed down so as to give flat surfaces perpendicular to the axis of the heater.

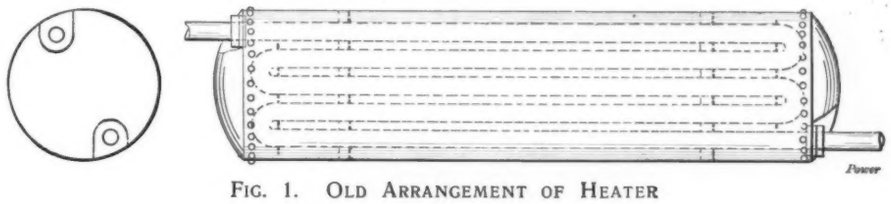


Fig. 1. Old Arrangement of Heater

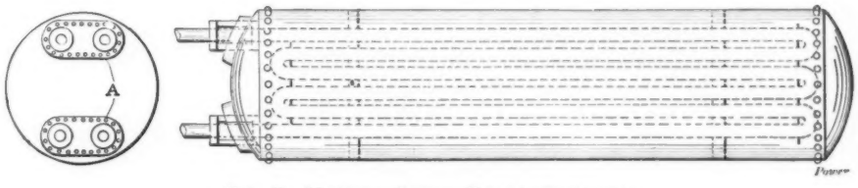


Fig. 2. Heater After Reconstructing

The heater has now been in use about two months since being rebuilt and has given better service than it ever did before.

H. A. Munyan.

Syracuse, N. Y.

Questions Before the House

Comment, criticism, suggestions and debate upon various articles, letters and editorials which have appeared in previous issues.

Cylinder Lubrication

As there seem to be quite a few articles on "Cylinder Lubrication" appearing in POWER, I submit herewith a brief description of the engines and the amounts of oil used where I am employed. We have four, variable-speed, throttle-governed engines, the cylinders of which are 15x16 inches in size, built by the Ball Engine Company. The engines are equipped with their builders' regular telescope valve, and run at an average speed of about 200 revolutions per minute, 144 hours per week. We carry 100 pounds steam pressure and use a very common grade of cylinder oil. We use 1⅓ pints of oil per cylinder per 24 hours and seem to get very good results.

J. SHORT.

Hamilton, O.

I have read closely the several very interesting articles on "Cylinder Lubrication" which have been published in POWER. I believe that the most important feature of this question has not been properly emphasized, that is, the saving in work accomplished by the proper use of cylinder oil.

Of course, we do not want cylinders and valves cut or worn, and in the letters so far written, this seems to be the only point made or discussed. I noticed that Mr. Wilson expressed the intention of starting a 400-horsepower engine without oil. If he investigates, he will find that his fuel cost will increase to such an extent that he could use oil of the maximum price and quantity and still be away ahead in point of cost. For over 20 years I have been engaged in investigating lubrication under many and varied conditions that prevail in the Southeastern States, making an average of 32 actual, practical tests every year, and I have found that local conditions govern entirely the nature and quality of lubricant necessary to secure maximum service.

I find that, as stated above, the idea seems to prevail among engineers that if they can keep cylinders and valves from cutting and wearing, that is all that is needed. This is entirely short of the real reason for using an internal lubricant. The real reason is for the purpose of saving power, fuel and repairs, and it is obvious that if we do that, the question of cutting and wearing will disappear.

I made a very thorough test some years ago to determine the difference between two cylinder oils which were sold at the same price, one being a filtered oil and the other a black. The engine was a Corliss, 22x48 inches in size, running simple, condensing and at 640 feet piston speed per minute, under 125 pounds boiler pressure. The regulation being very good, we indicated under friction load, which consisted of the mill shafting with all belts on loose pulleys. We took ten diagrams at intervals of five minutes with the filtered oil and found an average friction load of 64.52 horsepower. We then put on the black cylinder oil, ran a week and then made another indication under exactly the same conditions. A friction load of 59.62 horsepower was shown, indicating a net reduction in friction of 4.90 horsepower. Not being satisfied with this, we repeated the test after running nearly a month on the black oil. The last test showed a friction load of 57.42 horsepower with the black oil, and with the filtered oil 63.11 horsepower.

Now, if this difference in friction exists, as it does, between two different oils, both high-grade, will someone compute the difference between oil and no oil? As near as we can compute it, over 80 per cent. of engine friction is in valves and cylinders. Now, if we can reduce that even 10 per cent., it will more than repay us for the oil used regardless of cost.

I notice that many correspondents use as an argument the fact that little oil is used internally at sea. This is true and very unfortunately so, for if they could use cylinder oil at sea, it would very much reduce the cost of fuel and repairs. The reasons for not using internal lubrication at sea are twofold: First, all ships use all their exhaust condensation for boiler feeding. Second, with the distilling plants, it is impossible entirely to remove the salt, and by using any appreciable amount of oil they endanger the boilers. Again, when boiler-feed water has even a trace of salt, cylinder oil is of little use, as it will not stick to the rubbing surfaces.

I observe that there is quite a difference in opinions as to the relative values of the dark and the light cylinder oils. My experience teaches me that greater efficiency can be obtained with black oil, as it contains all the carbon properties of the crude oil, which is all black. By reducing the natural stock by filtration to make it light, it is necessary to remove a large percentage of mineral hydrocarbons. It then becomes necessary, before the light stock can be made to stick to rubbing surfaces and to furnish any degree of lubrication, that the mineral hydrocarbons be replaced with either animal or vegetable hydrocarbons, which are known to be much inferior to mineral hydrocarbons, not only as lubricants but also because they are subject to the development of free acids which are injurious.

F. A. DILL.

Baltimore, Md.

So far as I have noticed, most vertical engines can be run entirely without, or at the most with a very small quantity of, cylinder oil, provided some care is taken to have the steam reasonably dry. In some cases I have noticed that a good separator at the throttle has made it possible to reduce the oil from the customary three drops per minute to about one every three minutes. As stated by Mr. Alling, in a recent issue, occasionally the piston rings and slide valve will set up a more or less distressing groaning, but feeding a few drops of oil will soon quiet it. I have allowed a small engine, which I was not afraid of injuring, to run on unattended, and found that after a time the groaning would stop as suddenly as it started. In nearly every case when the noise was at its loudest, water could be seen running down the valve stem and piston rod, confirming for me the idea of wet steam being responsible to a great extent. I never noticed any undue cutting or wear on this engine.

As regards horizontal engines, the question of cylinder lubrication seems to be another story. In one plant of which I had charge some years ago, were two horizontal engines having 11x12-inch cylinders and making 200 revolutions per minute. We used Valveoline. From the appearance of the lubricators, the man before me had been in the habit of giving them a dose of a pint or so and then forgetting all about them. I started cutting down the oil supply slowly. All went very nicely until a rate of about one drop per minute was reached, when slight groaning commenced. I reduced the oil no further. At about this time, our entire supply of cylinder oil, ten or twelve cases, was carried away by a rise of the river. Although we tried our best, we could obtain no further supply for seven or eight days, being in a remote section. I tried some gas-engine

oil which we were using in air cylinders with poor results. That giving out also, I used plain engine oil which, of course, was worthless. By the second day the engines were groaning badly. On the third day it took two assistants with bars to start them off the centers. Here I would have quit, but the superintendent insisted on keeping things moving. One morning, I noticed that one of the cylinder drains which leaked would spit water every time there was a particularly painful groan. Just then the noise of the blowoff being opened drowned the squeals. When the former noise ceased I noticed that the groaning was much less. I naturally jumped at the conclusion that wet steam complicated matters. After this, the keeping of the water level as low as I dared certainly made things work smoother, but by the time the oil arrived several days later, the engines were about at their last gasp. It took several days and plenty of oil to make these cylinders silent again, although they were not damaged to any extent; which to me at the time seemed remarkable. The gas-engine oil which we had used was found in the exhaust head and on the roof in as good shape as when it left the lubricator. The engine oil, as was expected, just went up in smoke.

O. MONTHAN.

Tucson, Ariz.

I have read with great interest the article on "Cylinder Lubrication" but up to the present I have not read of a case that parallels an experience which I had some years ago with a pump.

This pump was located in a mine, 600 feet below the surface and was used to keep the mine clear of water. The steam cylinder was 14x16 inches and the water end was 8 inches in diameter.

The steam line from the boilers to the pump was 700 feet long. As the lubricator was located near the boilers, the oil had a good chance to mingle with the steam before it reached the pump. I tried the best grades of cylinder oil but, invariably, as soon as the oil started, the pump would stop; then I would have to cut off the oil and go down the shaft and sit in a cold shower of seepage, cranking the valve gear for a half hour before the pump would again run alone. Try as I might, I could not feed the cylinder oil slowly enough. If I stopped the oil entirely, the pump, after an hour's run, would stop also. I experimented with tallow, graphite and kerosene but all to no avail. Red engine oil was also a failure. I got the best results by mixing engine oil and kerosene in equal proportions, and feeding as slowly as possible.

At a point 200 feet below this pump was a 12x14-inch Knowles sinking pump. This pump ran smoothly and gave the best results with seven drops per minute of a heavy cylinder oil. As this pump had a separate steam line to the boilers, it could in no way interfere with the operation of the other pump.

Recently, I installed a new 5¼ and 3½ by 5-inch duplex, boiler-feed pump. All the oil and graphite in town could not keep it from groaning and screaming. As all the steam generated is used for cooking and baking, I had no other cylinder to experiment with. Two weeks ago I changed the boiler compound. Today my pump uses one drop of oil per minute and if I turn my back I cannot tell whether it is running or not.

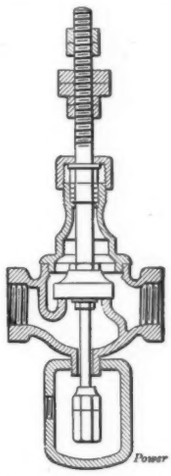
I have read of several trying to run without cylinder lubrication, but has any one succeeded? It may be possible with vertical cylinders, but with the horizontal —well, I want to be shown, and I am not from Missouri, either.

JOHN H. HIEBER.

Spokane, Wash.

Bundy Return Trap Valve

I wish to call attention to the article on page 514 of the issue of March 15, headed "Operation of Bundy Return Trap." The writer of this article has neglected to tell how the water gets into



SECTION THROUGH VALVE

the bowl, and this is the question that is most frequently asked.

In the second paragraph he speaks of a globe valve. This is not a globe valve, but is a double-seated valve, as shown in the illustration, the upper seat being connected to the steam space of the boiler and the lower opening to the atmosphere. The operation is as follows: When the trap is in the filling position, the interior of the bowl of the trap is open to the atmosphere through the bent pipe and the vented valve so that there is no pressure in the bowl. The discharge check is kept closed by the pressure from the boiler. Now, the water of condensation is forced into this trap by the pressure behind it until it gets within 2 inches of the top of the bowl. Then the bowl drops, closes the vent and admits steam from the boiler and as the trap is located above the water line of the boiler, the water flows into it by gravity. When the bowl is empty the weight on the lever returns it to its filling position, and the steam remaining in the bowl is vented to the atmosphere, relieving the pressure and allowing a new charge to enter.

There should be a valve or cock on the vent so that it can be regulated according to the work to be done. When everything is cold the vent should be wide open, but when the water is very hot, only partially open so as to prevent the evaporation of this water due to its temperature, especially when it comes from high-pressure systems.

J. JONES.

Passaic, N. J.

Water Tank Indicator

Mr. Heyrodt, on page 319 in the February 15 issue, pokes fun at an idea for a water-level indicator which I advanced as being free from undue complications.

Mr. Glick, on page 648 of the April 5 issue, also is interested and asks a few pertinent questions. Perhaps I can explain matters satisfactorily.

The idea of transmitting the pressure due to the static head developed by a column of water, originated with a Greek philosopher named Hero, who flourished about 200 B.C. He made a piece of apparatus known to us as Hero's Fountain, which, seemingly, performed the impossible. Water flowing from an open vessel into a closed tank causes the air in the tank to undergo compression. This pressure is carried to another closed tank, situated at the level of the first open vessel and the water contained in the second closed tank is forced upward through a discharge pipe and forms the fountain.

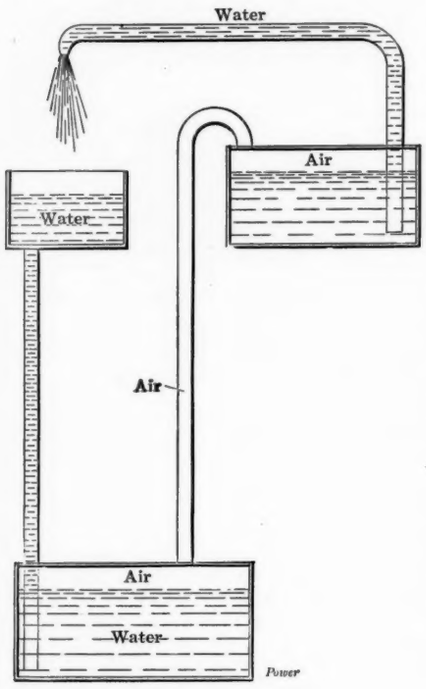
Mr. Glick has the right idea when he asks, why not hook the gage directly onto the discharge pipe. If this is done, the only difficulty is that the difference between high and low water is hardly noticeable when the tank is elevated more than 50 feet.

I have in mind a tank which was under my charge for a while. It was located 98 feet above the engine-room floor. The difference between high and low water was 5 feet; and the pressure difference between these two heads was only 1.8 pounds per square inch which would hardly be noticeable if, in selecting a gage to record the pressure, we bear in mind that the scale should read to about twice the normal pressure.

I agree with Mr. Glick that my plan would not work very long due to the water absorbing the air in the tube. Most engineers would be happy, judging from the number of ingenious plans to notify them of low water, were any system to work for a few weeks at a time without a hitch. The air absorbed by the water

would be replaced every time the tank was allowed to empty for cleaning purposes, etc.

It may be of interest to mention that the only other application of Hero's Fountain of which I am aware is in one of the most modern as well as most



HERO'S FOUNTAIN

sensitive of indicators in existence, namely, the phthysmograph, an instrument which will measure the variations between two heart beats, and which, because of its accuracy in this respect and because of certain physical processes relating to the heart which go on when a falsehood is told, will indicate when a lie has been told.

WESLEY MCARDELL.

Brooklyn, N. Y.

I have read with interest the different articles under the title "Water Tank Indicator," one of which appeared in the April 5 number.

I would suggest to Mr. Glick that if he will buy an altitude gage and connect it to the bottom of the pipe as he suggested doing with an ordinary gage and then fill the gage pipe with water to the bottom of the tank, he can then adjust the hand on the gage to zero and will not need to make any further adjustment or calibration as the gage can be read directly in feet of water.

A. K. GATES.

Omaha, Neb.

Oil as a Cause of Boiler Failure

Referring to the description of a flue collapse in a Lancashire boiler, in the issue of April 5, there can hardly be any doubt but that this accident was a clear case of bagging, or, as some call it, a dropping of the furnace sheet caused by the overheating of the metal in consequence of a deposit of scale.

That such was the cause of the disaster can readily be seen from the bulging shape of the top furnace sheet, shown in the illustration, which is the form usually taken when the sheets are overheated from any cause, but particularly from greasy scale.

It would be interesting to know just what the quality was of the feed water which was supplied to this boiler, and also what the nature of the scale was, or whether the latter contained any oily or greasy deposit, which is so frequently fatal to boilers of every kind.

An examination of the records of furnace collapses and tube ruptures will show that in a large majority of cases they were caused by oil and grease deposits resulting from imperfectly filtered condensate which had been used as boiler feed, and which readily deposited its oily contents upon the furnace sheets.

Difficulties of this kind are quite frequent even when the feed water contains but a fraction of a grain of oil per gallon. In the long run, these fractional and apparently insignificant amounts of grease or oil, which resist all attempts to filter them out by ordinary methods, are bound to bring boiler troubles resulting in bagging and explosions.

The only safeguard against such dangers is, therefore, a pure, clear feed water, devoid of all traces of grease, if the condensed steam is used over again, or a soft water free from mineral matter in solution.

While there is no direct evidence that oily scale was the cause of the disaster in question, doubtless many readers will at once recognize the similarity in appearance between the bulged portion of the collapsed boiler, shown in the illustration, and many instances in which greasy deposits caused by oily feed water were known to have been the direct cause of the trouble.

ARTHUR E. KRAUSE.

Jersey City, N. J.

Steam Liberating Surface

In response to your editorial in the March 29 issue of POWER on "Steam Liberating Surface," I submit some figures and other data relative to this matter, which I obtained while testing a boiler in my plant last February.

The object of the test was to determine whether it was economical to try to use this boiler alone or to use another of smaller size with it.

The boiler in question is of the horizontal, tubular type, 60 inches in diameter and 18 feet long; it contains 84 three-inch tubes. The tubes are pitched 4 inches both ways except in the center where a 2-inch space is left between them. The boiler is provided with a steam dome 30 inches in diameter by 36 inches in hight. This dome is situated directly over the bridgewall of the furnace. Steam is taken from the boiler through a 4-inch pipe, screwed into a flange riveted to the top of the dome. This pipe does not extend through the head of the dome.

Nearly all of the steam is condensed and returned to the boiler as feed water, not over 5 per cent. of make-up water being required, and this is of very good quality. The water is supplied constantly by a duplex steam pump at about 150 degrees Fahrenheit and enters the boiler through the blowoff pipe. The boiler is blown down twice daily and is cleaned about once in six weeks, at which time we usually get about a peck of scale and mud, principally the latter.

The coal used is anthracite, pea size, having a heat value of about 12,000 B.t.u. per pound.

The grate is 5x6.5 feet in size, having an area of 32.5 square feet.

The figures are arranged in tabular form, under two heads. The first test was made with the water level carried at a point 10 inches from the top of the boiler shell and the second with the water level at 16 inches from the top.

	Test No. 1. Water Level 10 Inches from Top of Shell.	Test No. 2. Water Level 16 Inches from Top of Shell.
Coal per hour, lb	425	500
Water evaporated per hour, lb	3,500	3,800
Heating surface, sq.ft	1,330	1,330
Grate surface, sq.ft	32.5	32.5
Steam pressure, lb. gage	60	60
Feed-water temperature, degrees F	150	150
Heat value of coal, B.t.u.	12,000	12,000
Steam space, cu.ft.	53.7	90.6
Liberating surface, sq.ft.	67	80

With the water level 10 inches below the top of the shell and at the rate of evaporation given in the table for test No. 1, priming began. The amount of coal burned was increased to about 525 pounds per hour but priming became so violent that no reliable figures could be obtained. Water fed to the boiler at this time was at the rate of about 4100 pounds per hour.

At this rate of evaporation and with the hight of water given in the table for test No. 2, priming began. The coal burned was increased to the rate of about 575 pounds per hour and the priming again became violent. The water rate at this time was about 4500 pounds per hour.

There are some things about these figures which I do not understand and I should be glad to have the opinions of others in regard to them.

For instance, why should 67 square feet of water surface in the first test liberate more steam with the same ap-

parent amount of priming than did the 80 square feet in the second test?

Again, why should the small increase in the rate of combustion make such a great difference in the amount of priming?

In both cases, when the rate of combustion was increased as stated, the priming became so violent that the separator in the steam line could not take care of the entrained water.

I hope that these figures may be of some use although they are not as complete as could be desired.

H. A. MUNYAN.

Syracuse, N. Y.

Boiler Accident(?)

In the April 12 number, on page 671, is given a short account of an accident at the Teachout Boiler Works in Cleveland. It is stated that steam was admitted to a boiler in which a man was working and as a result he was severely burned. As I am well acquainted with the shops in question and as there is only one boiler there, I was at a loss to understand how steam could be turned into it. Consequently I called upon the superintendent and got the particulars of the accident which are as follows:

On a certain Saturday afternoon, which is pay time, the superintendent gave orders to one Theodore Gordon (the one who rapped on the boiler for help) to assist the engineer to clean the valves on the air compressor, the next day, Sunday. About 10 or 11 o'clock on Sunday a teamster came down to the shops and as there was no steam in the boiler, the teamster and Gordon proceeded to raise steam of a different sort by making a number of trips to a place, not far from the shop, where the man behind the bar turned the valve at the end of a pipe which led to a beer keg. I am not so sure but that this may be the same valve referred to in the article in question. This valve-turning operation was performed quite a number of times before the air-compressor job was finished. About the middle of the afternoon the teamster and Gordon departed from the plant, leaving the engineer to finish the job.

From an account by one of the boilermakers it appears that during the week previous someone had told of a horrible experience he had had at one time inside of a boiler (he probably read the yarn in POWER where it was given, not long since, as the experience of an inspector).

At about 1 a.m. Monday, an employee of the American Steel and Wire Company found Gordon much the worse for wear under a trestle at a railroad crossing about a mile from the shop. Gordon described in stirring terms the harrowing experience he had had on the inside of the boiler, having recollected the details from the account given to him during the week, and as a consequence he secured a free ride home in an ambulance. Gordon reappeared for work on Tuesday morning. About a week later the Teachout Boiler Company received a bill of $10 for ambulance service, whereupon the boss asked Gordon if he knew who was going to pay the $10. Gordon guessed that it was up to him, and so it was, for he was $10 short on pay day.

ALBERT IHLENFIELD.

Cleveland, O.

[The short account in the issue of April 12 was an attempt on our part to give advance information from the daily press, which we did not have time to verify.—ED.]

On Putting It Up to the "Old Man"

I read with interest the letter by George Pehlman in the current issue, "On Putting it up to the 'Old Man.'" It is that old, old story of the layman dictating in matters that are technical. Doubtless a good many engineers could relate the same sort of experience. Yet the number of men who discount or ignore the counsel and suggestions of their engineers is getting smaller and smaller.

The tendency seems to be to let the engineer attend to the things that come within his province. The employer says to the engineer:

"I pay you for inaugurating and maintaining efficiency and economy in the boiler room. If you can do what I think you can, you'll be worth lots of money to me and you will increase your wages just as fast as you increase my margin of profit. If you can't, you won't be worth the space you occupy."

The engineer is not only permitted but expected to take the initiative in suggesting new ways of doing things and new equipment. He may not always get what he wants but he will be given a hearing and everything he says will receive due consideration. Many times an engineer has only himself to blame for his failure to get what he wants. He does not go deep enough into the subject in hand to speak with confidence and enthusiasm. He puts up a poor case and he fails. I am reminded of an engineer I met not long ago. He kept his eyes and ears open all the time for new ways of cutting down operating expense. When he saw something that looked good to him he began to post himself on the subject. He dug deep. He fortified himself with facts and then put it up to the "Old Man." He generally got what he wanted. He was turned down once, however, and this is the way he won out. Said he:

"Now, look here, I'm asking for this in your interest. I know it's going to save you money. I admit there's also a selfish motive back of it—I want to make good. If you don't want to buy it, let me do it. But if I buy it I think I'm entitled to the saving made through its use and I want you to give it to me."

The assurance and authority with which he spoke won his case.

This brings me to Mr. Pehlman's question, "Is it advisable for an employer to become acquainted with his engineer, and why?"

Without endeavoring to answer it I have this to say: I know of nothing that will bring the engineer and the "Old Man" together so quickly as results. And when results bring men together the men hang together pretty well even though they may not be particularly stuck on each other. More often, though, the men become friends. The business world furnishes thousands of instances to prove this. Let us take a concrete case and, since Mr. Pehlman has mentioned the subject of coal, suppose we take that. Heavy fuel consumption is one of the signs of scale. There are good tube cleaners on the market that can be tried free of charge and without obligations to purchase. One boiler can be cleaned. The results would be immediate and positive. The "Old Man" could be asked to come down and see the pile of scale. There's nothing like indisputable evidence of work done. I venture to say that the "Old Man" would smile. Then he could be told that that is what has been eating up a large part of the coal. Then for a month or so the coal pile could be watched and if there wasn't less used during that period than there had been for the same period when the boiler was dirty, I've missed my guess.

Thus, step by step, the "Old Man" could be "shown." And when it came to the matter of purchasing the cleaner, it could be pointed out that the cleaner was guaranteed to pay for itself in a given period. Most boiler-tube cleaner manufacturers make some such guarantee. Suppose this course was taken, doesn't it seem reasonable to suppose that the "Old Man" would give in?

H. E. GANSWORTH.

Buffalo, N. Y.

I read with interest Mr. Pehlman's article in April 12 number of POWER. I think that the "Old Man" is very wrong in his attitude and am led to believe that if he were a little more open minded he might change his view of the situation. Of course, it cannot be expected that all men in a position such as I imagine him to be in will know all about the operation of a power plant nor what and how much is required, but it is his duty to find out. The only way in which he can find out is by observation, and by questioning the operating engineer. He should then secure figures from other power plants and operating engineers on the information he desires and then make

a comparison. I think that everybody would be benefited as a consequence.

Yes, I think that the only thing for the employer to do is to become thoroughly acquainted with the operating engineer. The more acquainted he becomes, the better it will be for him, for the reason that he will be able to "size up" his engineer better, and the engineer will be better able to understand what is required and work to much better advantage.

In thinking over Mr. Pehlman's situation, I am of the opinion that if he were given charge of everything pertaining to the power plant, the "Old Man" could spend his Sunday afternoons having a social chat with his engineer instead of a business talk.

T. J. HAMMERSLEY.

Milwaukee, Wis.

Calculation of Power Loss in Slipping Belts

It is said that figures do not prevaricate. That is as far as I dare to go with this quotation. It is always pleasant to have mathematics to prove what one believes, but it is well to temper one's mathematics with common sense.

On page 713, an article on the subject of slipping belts uses several hundred words to get a mathematical expression for the power lost by a slipping belt. To start with, it assumes that the tension on the slack side of the belt is 135 pounds, and on the tight side 300 pounds, making a net pull of 165 pounds, which, at the belt speed given, namely 2000 feet per minute, will transmit 10 horsepower. The total belt slip is also assumed to be 10 per cent., referred to the belt speed.

Now, after calculating the unit pressure around the arc of contact of each pulley, the article assumes the coefficient of friction of 0.2, and calculates that the "grip" of the belt on one of the pulleys is 123 pounds, and on the other pulley is 154 pounds. If it requires 165 pounds of pull in the belt to transmit the 10 horsepower, which end of the belt is actually receiving the 10 horsepower? If neither end is receiving it, from what source comes the extra pull required to make up the full 165 pounds in the middle of the belt? The pull on each pulley must be alike, and the same as at the middle of the belt. According to the article in question, and the mathematics therein, this does not come from the force exerted by the contact of the belt upon the surfaces of either pulley.

It seems to me a little more reasonable to assume that the actual belt pull of 165 pounds is slipping over the surface of each pulley at a speed equal to the difference in the speed between the belt and the pulley. As the original assumption was that the slip on the motor pulley amounted to 120 feet per minute, why would not the loss be equal to 165 pounds multiplied by 120 feet, or 19,800 foot-pounds per minute? In the case of the other pulley where the slip is assumed to be 80 feet per minute, why is not the loss equal to 165 pounds multiplied by 80 feet, or 13,200 foot-pounds per minute? The sum of these two amounts to 33,000 foot-pounds per minute, or one horsepower lost. As the slip was calculated at 10 per cent. referred to the belt speed, it is not reasonable that the power loss should be one horsepower, or 10 per cent. referred to the power carried by the belt?

This seems very good mathematics and common sense to me, although, of course, I may be wrong. As a matter of fact, the probable trouble with the argument is that the wrong coefficient of friction between leather and iron, to suit the slip assumed, was taken. If this coefficient of friction had been just right, to suit the other assumptions which were made, or the slip had been made correct to suit the coefficient of friction and the unit pressure, the actual loss would have figured up to one horsepower, just as I have made it, instead of ⅞ horsepower, as he has it. Truly, a little mathematics is a dangerous thing.

S. R. BENEDICT.

New York City.

When a certain conclusion can be reached by several methods of reasoning, most of us prefer the simplest one, as it is least liable to lead us astray. This is the excuse for the following article upon rather an ancient subject.

By using part of the data given in the article "Power Loss of a Slipping Belt," which appeared in POWER of April 19, I would like to point out that the *correct* answer can be obtained in a more direct way.

All we need to know is the percentage of slip of the belt; this is given as 10 per cent., the two belt tensions are given as $T_1 = 135$ pounds $T = 300$ pounds, and the lineal speed of a point on the rim of the driver, 2000 feet per minute.

In the article in question, 2000 feet per minute was given as the speed of the belt but this figure was used as the speed of a point on the rim of the motor pulley.

The fact that there was 10 per cent. belt slip, means that a point on the rim of the follower was moving 10 per cent. slower than a point on the rim of the driver. In this case a point on the rim of the second pulley was moving 1800 feet per minute.

The difference in belt tensions was,

$T - T_1 = 300 - 135 = 165$ *pounds;*

that is to say, the net pull tending to turn the follower was 165 pounds. Therefore, the power received by the second pulley was

$165 \times 1800 = 297{,}000$ *foot-pounds per minute.*

The driver, however, ran at 2000 feet per minute. The net pull at the driver was, of course,

$300 - 135 = 165$ *pounds*

so that the power delivered by the driver was

$165 \times 2000 = 330{,}000$ *foot-pounds per minute.*

The power loss is, therefore,

$330{,}000 - 297{,}000 = 33{,}000$ *foot-pounds per minute,*

or one horsepower. This is 10 per cent. of the total power so that we find that the percentage of loss of power due to a slipping belt is equal to the percentage of the slip of the belt.

P. L. WEIMER.

South Bethlehem, Penn.

Installing Globe Valves

I noticed an article on "Installing Globe Valves" in the issue of April 12, contributed by C. C. Harris. While Mr. Harris has advanced some good illustrations regarding the use of these valves, I fail to agree with him. I believe that the proper place for the pressure is underneath the disk and not on top of it. Take, for example, a 2-inch globe-valve seat or disk, the area of which on top of the disk holder is 5.411. This multiplied by the pressure of the steam, which in this case we will assume to be 80 pounds to the square inch, gives the tremendous pressure of 432.886 pounds at the shoulder or collar on the end of the valve stem, which is only 3/16 inch larger than the valve stem itself. This large pressure has to be pulled away from the seat by this small rim or collar, whereas, when the pressure is underneath the steam itself does the work. Another reason for having the pressure under the seat is the inability to pack the valve stem if the pressure is on the top of the disk holder. Suppose that the main valve on the top of the boiler should have the packing blown out around the stem during working hours, how would Brother Clark repack it without letting all the steam out of his boiler? If the pressure was underneath the disk the trouble could be corrected in 10 or 15 minutes. Regarding the wear on the thread of the stem, this is open to discussion. In my opinion, the pressure exerted upon the thread to drag it away from the seat is the more harmful.

I do not contend that composition disks will not wear and leak, although all the valves in my plant have the same composition disks and I have experienced very little trouble with them. If Brother Harris had simply faced up the seats of those valves which leaked and had substituted a copper disk, I think there would have been no necessity of reversing the position of the valves to get a tight joint.

Regarding the possibility of throttling the steam and the method of putting washers or shims between the end of the stem and disk holder, it must be borne in mind that this looseness is intentional by the makers, to a certain extent, in order to allow the disk to adapt itself to the seat of the valve under any and all conditions of wear and, therefore, the valves must not be shimmed too tightly.

There is another point of contention in Brother Harris' article. Why is it more necessary to bypass a large valve, installed in this manner, than a smaller one? Large valves are sometimes bypassed for drainage purposes. The different sizes of valves are made proportionate as regards size and strength and if the idea is sustained that owing to the tremendous pressure on top of the disk it is impossible to open them unless they are bypassed, then this certainly is a good argument in favor of installing them as they are intended to be, with the pressure underneath the disk and not on top of it.

CHARLES H. TAYLOR.

Bridgeport. Conn.

In the plant where I am employed globe valves are used on lines from 1½ inches down to ¼ inch in diameter. The plant is in continuous operation and every piece of machinery is in duplicate. If we followed the practice advocated by Mr. Harris, what opportunity would we have to patch valve stems or, to put it in another way, how much horsepower would we donate to the atmosphere in the course of six months? There is nothing pleasant, when hearing steam blow from a valve stem, in finding that the valve is put in "backward." When the valve is in a header or is the first one from the boiler, I would feel much more at ease, when inside of the cold boiler, if I knew that the pressure from the other boilers on the line was against the top of the disk—stems are sometimes carried away.

I believe that if Mr. Harris will use a fairly good valve and keep the man who uses a monkey wrench to open or close a valve busy cleaning the engine or sweeping the floor, he will not be troubled much with leaky valves.

B. F. HARTLEY.

Tipton, Cal.

Engineers' Stethoscope

Referring to the article, "The Engineer's Stethoscope," in the April 26 issue, I wish to state that I prefer a regular physicians' instrument to any hastily prepared one. As the regular instruments are listed from 90 cents up, they can hardly be called expensive. I have found a $1.25 instrument all that I desired.

Mr. Daney refers to using a cracked receiver. I once spent some time trying to locate a peculiar sound that I perceived by the use of a homemade instrument in the machine under examination and finally traced it to the grating caused by a loose part of the instrument itself, so I should fear trouble from the use of cracked instruments.

Sometimes it is very desirable to record the loudness of a pound or other noise about a piece of machinery, or in some way measure it so that at some distant place and time something similar may be reproduced. A means which I have used with some satisfaction is to use two telephone receivers on a head band, suitably wired with flexible lamp cord to a small switchboard. To the switchboard the secondary of an induction coil was connected with a vibrator and adjustable resistance in its circuit. A telephone transmitter with a battery in the circuit is also connected to the switchboard.

If, now, the transmitter is held near to where the noise is produced, the exact distance from it being recorded, and by means of the switchboard it is connected to one of the receivers at the ear of the person making the examination, who should be at a considerable distance from the source of the pound, and if the induction coil is connected to the other receiver, the noise of the latter can be compared with the former, and by means of the adjustable resistance it can be made to equal it. If, then, the voltage of the battery on the induction coil and the other battery be noted, as well as the resistances in the circuit, it will be easy at any later date to make the coil produce the same noise in the same receivers, and so compare it with other noises.

F. W. SALMON.

Burlington, Ia.

Hot-water Meters for Boiler Feed

In the April 19 issue of POWER, Vasil Mackay's letter regarding hot-water meters for testing boilers was very interesting to the writer. It so happens that I have had an opportunity of observing the results obtained by using various kinds of apparatus for the measurement of hot boiler-feed water. There are three types of measuring devices to select from —the mechanical meter, the weighing machine, and the Venturi meter.

There are a number of different types of mechanical meters. In some the counter is controlled by the oscillation of a disk; in others by a miniature water wheel, and in still another type by the action of a piston. A mechanical meter having its mechanism actuated by the flow of water, as is universally the case, is not suitable for measuring hot water. The moving parts are soon affected by the heat and the meter becomes inaccurate. The only safe way to use a meter of this kind is to calibrate it before starting, and even then the same correction will not apply for different rates of flow. Also, a small piece of waste or other material in the feed water will often clog a mechanical meter, thereby partially or wholly plugging the line in which it is placed.

The weighing machine has the advantage of being accurate, but carries with it many disadvantages as well. It is invariably a large and unwieldy affair, requiring a permanent foundation and in passing through, a decided drop in the temperature of the feed water takes place, which means a direct loss in economy. The machine cannot be placed on the discharge side of a feed pump, as it will operate properly only under atmospheric pressure. Consequently, in some cases it is necessary to have a small auxiliary pump to force the feed water into the weigher.

The Venturi type of hot-water meter seems to meet the requirements of this service better than the two foregoing means. It is simple and has proved accurate and durable. There are two parts to a Venturi installation: First, the meter tube, which is placed in the feed line; and second, the instrument which may be placed in any convenient location within 75 or 100 feet of the meter tube. The hot water passes through the meter tube only, and does not enter the instrument. The instrument is operated by the difference between the pressure at the inlet and that at the throat of the meter tube, but, however, causes no permanent loss of pressure. These two pressures are carried to the recording instrument by two small lines of piping. Several different kinds of instruments may be used, from the simple U-tube mercury manometer to an instrument which indicates on a dial the rate of feeding, makes a chart, and records the amount of water fed to the boilers.

An outfit which gives such complete information is useful not merely for occasional tests, but by observation of the indicating dial the rate of feeding may be easily regulated so as to give the best results. Uniform feeding of boilers usually means uniform temperature of the feed water, a condition much to be desired. The charts form a continuous record of the load on the plant, showing peaks and decreases. Boiler-room economy is constantly being given more attention, and a reliable hot-water meter is a necessity.

N. L. SAMMIS.

Providence, R. I.

In the letter by C. W. Naylor, which appeared on page 817 of the May 3 number, it was stated that in Marshall Field's store there were installed the equivalent of 6000 incandescent lamps. Another cipher should have been added, to make the figure read 60,000.

The Selection of an Engine

By Cornelius T. Myers

A discussion of an article by W. H. Miller, which appeared in the April 12 issue. Mr. Myers takes the author to task upon several points, and submits a table showing what he believes to be a fallacy in the original selection of the engine.

In the April 12 issue there appeared an article quoting Warren H. Miller on "The Selection of An Engine." If his opinions have been correctly stated, I think they will bear a little friendly criticism, for he has touched upon a subject which is being almost daily considered by manufacturing concerns in all parts of the country. His article is timely and particularly interesting because the relative costs are given, although he does not say whether his figures include the freight and erection of the units. It would be of interest to hear the comments of other engineers, especially those doing consulting work in this particular line.

Mr. Miller mentions four kinds of prime movers: the marine engine, the steam turbine, the high-speed tandem-compound engine and the Corliss or four-valve engine. The turbine he quickly eliminates and quite correctly, though it is about the first instance of the kind I have seen in public print. The bids on marine engines were high and the type not more efficient than others offered. This narrowed the selection down to the high-speed tandem-compound and the high-speed Corliss or four-valve engine.

He confuses the last two mentioned, however, when he says "high-speed Corliss or four-valve engine." The Corliss engine is equipped with the releasing valve gear invented by George H. Corliss, which is its distinctive feature. The four-valve engine has the semi-rotative type of valve, resembling that used by Mr. Corliss, but the valve gear is of the nonreleasing type operated by a shaft governor, and it is not a Corliss engine. Rotative valves were used before the time of Corliss, but he invented the releasing valve gear which revolutionized steam-engine practice.

No basis of comparison is given for the engines, but as the 200-kilovolt-ampere unit was finally selected, let us take this size, compute the horsepower required, compare the sizes of the different engines and see how they compare with the conclusion reached by Mr. Miller. He says that he wants an engine to carry the load with low steam pressure and high back pressure, it also to contain as little complication as possible. As the simple four-valve engine is about as economical as the tandem-compound single-valve automatic, I will confine the comparison to the first group of figures—that from which he finally selected the 18x17-inch four-valve engine.

Two hundred kilovolt-amperes at 85 per cent. power factor is equivalent to 228 electrical horsepower. Taking 91 per cent. as the full-load efficiency of the generator and 10 per cent. (for four-valve engines) as the value of engine friction and windage, will give 278 as the indicated horsepower of the engine at full load. The following table is part of the one given by Mr. Miller, to which I have added the last four columns.

From the cylinder sizes given it would seem that bidders *A*, *C* and *D* offered Corliss engines, while bidder *B* offered four-valve high-speed engines. In my calculations I should have used 8 per cent. as the friction and windage of the Corliss engine instead of 10 per cent. as above stated; and I might have also allowed the Corliss engine two pounds more mean effective pressure at one-quarter cutoff, than the four-valve engine, on account of the smaller diagram area shown by the four-valve engine. Doing this, however, would further widen the discrepancy between the engine selected and the engine I believe best suited to the conditions.

Bidder.	Size.	R.P.M.	K.V.A.	H.P., Builders' Rating.	Cyl. Disp., Cu.Ft. per Minute.	I.H.P., 100 Lb. Steam, 26-in. Vac., ¼ Cutoff.	I.H.P., 100 Lb. Steam, Exhaust at Atmosphere, ¼ Cutoff.	I.H.P., 50 Lb. Steam, 4 Lb. Back Pressure, ¾ Cutoff.
1	2	3	4	5	6	7	8	9
A ..	18x30	150	200	242	1315	337	270	230
A ..	16x30	150	150	152	1045	269	210	181
B ..	20x19	150	200	200	1025	263	210	179
B ..	18x17	{225 / 189}	200	200	{1125 / 900}	{290 / 232}	{232 / 185}	{198 / 158}
C ..	16x30	150	200	200	1045	269	215	184
C ..	14x30	150	150	150	825	211	169	144
D ..	16x36	150	200	200	1255	323	258	215
D ..	14x36	150	150	150	990	255	204	174

Just how Mr. Miller arrived at his figures for the horsepowers is hard to tell and there are some very apparent discrepancies; for instance, *A* bids on a 16x30-inch engine rated at 152 horsepower while *C* bids on one the same size, which at the same speed is rated at 200 horsepower.

The well known formula for figuring the indicated horsepower of an engine is

$$I.H.P. = \frac{PLAN}{33{,}000}$$

Now, *P* (the mean effective pressure) being constant, as it must be in this instance as a basis of comparison, the horsepower of the various engines will be in proportion to *LAN*, which is equivalent to the piston displacement per minute. This is given in column 6, and it will at once be seen that the engine selected is not only the smallest one offered for the 200-kilovolt-ampere generator but even smaller than two of the engines offered for the 150-kilovolt-ampere generator. In fact, the 18x30- and the 16x36-inch engines excel the 18x17-inch in load-carrying capacity by about 46 per cent. and 39 per cent. respectively; and the 18x17-inch engine not only fails by 16 per cent. of being able to carry the full rated load of the generator under the most favorable conditions (given in column 7), but will carry only about 57 per cent. of full load under the conditions given in column 9—the very case for which the 18x17-inch engine is selected as being best suited. Even if this engine is speeded up to its maximum of 225 revolutions per minute it will carry only 72 per cent. as per column 9; whereas the 18x30-inch engine, at rated speed, will carry 83 per cent. of full load and the 16x36-inch engine 78 per cent. of full load.

But Mr. Miller arbitrarily rule out the 18x30- and the 16x36-inch engines, principally because their piston speeds were too high, 900 feet per minute for *D* (16x36), and 750 feet per minute for *A* (18x30) and *C* (16x30) inches. This is in spite of the fact that there are hundreds of Corliss engines which for years have been successfully operated at piston speeds from 800 to 1000 feet per minute. Further it is well recognized among engine builders of experience that high piston speeds mean better steam economies, for the larger the volume of steam worked through a given cylinder the smaller is the percentage of condensation therein. If the engine cylinder is considered as a more or less complicated steam pipe with a certain radiation factor the point just made will appear in its true light.

Immediately following the above contention comes this contradictory statement: "The 16-inch diameter single-cylinder engine did not appeal to us

either, even though it figures out all right at that high piston speed. It meant that the engine would lie down on low steam or high back pressure or heavy overloads, simply for lack of driving power in the piston itself." The first sentence admits that the 16x36-inch engine will carry the load, but the last sentence infers that the relative piston areas determine the load-carrying capacity. As has just been shown, this is not the case, for if this were so, a 20x10-inch engine running at the same speed would develop over 20 per cent. more power than the 18x17-inch engine, whereas actually it will not develop 75 per cent. as much power as the latter, regardless of the steam- and back-pressure conditions.

As to the relative value, as machines, of these two types of engines much has been said, but not enough. There are too many flat statements made by manufacturers and especially their representatives, which in many instances are misleading, to say the least; and there is too little analysis of design and construction, too little reliable information as to steam economies, and there are far too few thorough tests available to enable the purchaser to accurately determine what engine will really pay the greatest return on the investment.

Possibly Mr. Miller has not given us every reason for his decision, but in any event he has done us all a favor in stating quite fully the details of the bids received and offering opportunity for discussion. If it will help create a feeling that all such bidding should be open and each item argued on its own merits, something has certainly been accomplished. If, now, the engineering press will urge and show the value, especially from the purchaser's standpoint, of testing every installation, it will not be long before we shall have some reliable data to guide us in designing power plants and purchasing prime movers, which will fulfil the demands of each plant with the highest economy.

Superheated Steam and Superheaters*

By D. S. Jacobus

A general discussion of the use of superheated steam and the increased efficiency resulting, data of comparative tests on the engines of the steam yacht "Idalia" being given as an illustration of the economy derived.

The opinion was long held in engineering circles that although a saving in the water consumption of a steam engine might be effected by the use of superheated steam, this gain was offset by the additional fuel required. Later experience has shown, however, that in a properly designed plant, a decided saving is effected, there being good evidence of this in the fact that some of the largest and most economical power plants of this country are using superheated steam.

In highly economical plants where the water consumption per indicated horsepower is already low, a smaller gain will result through using superheated steam than in less economical plants, the amount of saving ranging from 3 to 5 per cent. in the former case and from 10 to 25 per cent. in the latter. From tests on locomotives it has been found that a saving of from 10 to 20 per cent. resulted from the use of steam superheated to 150 or 200 degrees.

With a properly designed boiler and superheater, the efficiency of the boiler and superheater combined should be as high as that of the boiler alone. However, it does not follow that all superheaters placed within a boiler will be efficient, for if the gases are made to depart from the path they would ordinarily take, there may be a loss in efficiency.

When a properly arranged boiler and superheater are used in connection with an engine, the fuel saving will be less in direct proportion to the heat saving of the engine. To make this plain it might be well to explain what is meant by the "heat consumption" of an engine. If an engine uses 15 pounds of steam per horsepower-hour it does not necessarily follow that another engine using the same weight of steam per horsepower-hour will have the same economy as the first, for in one case the steam pressure or feedwater temperature may be higher or lower than in the other. If, however, we determine for each of the engines the heat imparted to the boiler per indicated horsepower, a comparison of these figures will give a true measure of the relative economy.

RESULTS OF "IDALIA" TESTS.

Date 1909	Oct. 11.	Oct. 14.	Oct. 14.	Oct. 12.	Oct. 13.
Degrees of superheat, Fahrenheit	0	57	88	96	105
Pressures, pounds per square inch above atmospheric pressure:					
Throttle	190	196	201	198	203
First receiver	68.4	66.0	64.3	61.9	63.0
Second receiver	9.7	9.2	8.7	7.8	8.4
Vacuum, inches	25.5	25.9	25.9	25.4	25.2
Temperature, degrees Fahrenheit:					
Feed	201	206	205	202	200
Hotwell	116	109.5	115	111.5	111
Revolutions per minute:					
Air pump	57	56	53	54	45
Circulating pump	196	198	196	198	197
Main engine	194.3	191.5	195.1	191.5	193.1
Indicated horsepower, main engine	512.3	495.2	521.1	498.3	502.2
Water per hour, total pounds	9,397	8,430	8,234	7,902	7,790
Water per indicated horsepower, pounds	18.3	17.0	15.8	15.8	15.5
B.t.u. per minute per indicated horsepower	314	300	284	286	283
Per cent. saving of steam		7.1	13.7	13.7	15.3
Per cent. saving of fuel (computed)		4.4	9.5	8.9	9.9

While it is admitted that high degrees of superheat involve certain operating difficulties, it is a well established fact that with moderate degrees of superheat, say, 100 to 200 degrees Fahrenheit, the difficulties have been overcome. The use of cast-iron fittings with the above amount of superheat has caused much discussion, some claiming that the fittings have deteriorated, while others claim entire satisfaction. This point is overcome in many plants by the use of cast-steel fittings which have demonstrated their fitness for this kind of service.

With a superheater installed within the boiler, the amount of superheat will vary, depending upon the class of fuel, the type of furnace, the condition of the fire and the rate at which the boiler is driven. This might at first seem a detriment, but it is a recognized fact that a constant degree of superheat is seldom required, and both engine and turbine builders state that their machines will run just as well, mechanically, with 50 degrees as with 100 degrees of superheat.

With an independently fired superheater it is possible to overcome some of the variations due to changes in load, but the danger of obtaining a very high degree of superheat is just as great as with those placed within the boiler. In fact, unless care is exercised there is danger of burning the superheater, if for any

*Abstract from a paper delivered at the annual meeting of the National Association of Cotton Manufacturers, Boston, April 27-28, 1910.

reason the plant should be shut down temporarily without cooling off the superheater.

Some months ago the author conducted a series of comparative tests between saturated and superheated steam upon the engines of the steam yacht "Idalia." The engines are of the four-cylinder, triple-expansion type, 11½, 19, 22⅛ and 22 11/16 by 18-inch stroke, steam being supplied by a Babcock & Wilcox marine boiler having 65 square feet of grate surface, 2500 square feet of heating surface and a superheating surface of 340 square feet. The auxiliaries consist of a 6 and 4 by 6-inch feed pump, an independent 6 and 12 by 8-inch air pump and a centrifugal pump driven by a 5 7/16 x5-inch reciprocating engine.

A summary of the results of the test is given in the accompanying table. It shows that with 105 degrees of superheat the saving in steam combustion was 15.3 per cent., and in heat consumption about 10 per cent.

Discussion

In reply to questions, Professor Jacobus explained that the independent superheater is smaller and therefore less efficient than the combined superheater and boiler. For 100 to 150 degrees of superheat it is not necessary to use the highly specialized form of fittings. He knew of many plants using 150 degrees superheat with ordinary piping and fittings that were running without trouble, but there are those which have had trouble. The best work is done with steel castings or forgings. There is a saving of 10 per cent. to be expected in ordinary mixed power plants using superheated steam of 100 or 150 degrees.

Colonel Meier asked why the "Idalia" tests of October 12, with a higher degree of superheat, showed only the same per cent. of saving in steam as the test of October 14 with a smaller percentage in the saving of fuel. To this Professor Jacobus replied that it was only one of the accidental variations in tests of this kind.

President Plunkett asked about the superheat which came from the use of vertical tubular boilers. Professor Jacobus replied that superheat obtained in that way was just as useful as superheat obtained with a regular superheater, although it did not go to such a high degree; it was a fact, however, that the first few degrees of superheat were of more advantage than those obtained later.

With saturated steam there is a large waste through the traps, which is avoided when superheated steam, even of a moderate degree, is used. With the moderate degree of superheat advised, there need be no trouble from its effect upon the engine. At the Rodondo tests no trouble was experienced with the gridiron valves of the McIntosh, Seymour engine. The engines should, of course, be designed so that there will not be undue distortion with the increased temperature.

A great many engineers do not realize what it means in economy to let a boiler get foul. A superheater should be arranged so that the tubes can be readily cleaned.

Professor Jacobus mentioned the case of a boiler being tested before and after cleaning the water-heating as well as the superheating tubes, the result being a marked difference in favor of the cleaner boiler. When asked what the difference would be in the efficiency of a 600-horsepower plant as between steam superheated 40 to 60 degrees and superheat of 100 degrees, Professor Jacobus replied that the gain due to superheat increases with the superheat, up to 100 or 150 degrees. When that gain is balanced against the capital invested, it is found to be on the side of the superheater. Above this range of superheat practical difficulties are encountered.

Course in Steam Power Machinery

A course in Steam Power Machinery will be conducted at Columbia University by Prof. T. M. Gunn from 9:30 to 12:20 a.m., Mondays to Fridays, from July 6 to August 17.

The material of this course is presented in the form of about sixty lectures, which are supplemented by outside reading required of the student. Frequent recitations will be conducted upon the subjects of discussion, and the student will be called upon to prepare sketches and make analysis of machines from observations in the museum, laboratory and power house.

Use will be made in the lecture room of actual machines for demonstration purposes and of models where necessary.

In order that the student may carry the study further in any one line in which he may be specially interested, references will be made to publications giving more detailed treatment of the subjects in question.

The subject throughout the course is the investigation of principles of operation, requirements of service and methods by which these requirements are met in existing machines.

An outline of the course is given in the following:

The steam-power plant as a whole, its duties, general principles of operation and the formation of a working system by the combination of the primary elements.

Methods of handling fuels and ash in the plant.

Combustion of solid, liquid, gaseous fuels; grates and furnaces, mechanical stokers and the prevention of smoke.

The production of draft by chimneys, by blowers and by steam jets, and its control by dampers, regulators and other devices.

The formation of steam. Evaporation, ebullition and priming. Effects of form upon circulation, heat transfer and priming. Circulation of gases and benefits of baffling.

Boilers. Their structure and features of operation. The leading types are studied and analyzed as to fulfilment of requirements for each type. Rules and statutes governing boiler installation and operation.

Steam and feed-water connections to boiler, gage glasses, try-cocks, safety valves, fusible plugs, blowoff connections and other attachments to boiler. Manholes and hand holes. Special devices for inducing circulation and drying the steam.

Feed-water supply and treatment; improvement of economy by feed-water heating and the reduction of corrosion and scale by feed-water purification. Open and closed feed-water heaters and economizers. Feed pumps, piping, valves and regulation of feed supply by hand and by pump governors.

Transfer of steam throughout plant and its treatment during transit. Flow of steam in pipes and consequent loss in pressure. Moisture and condensation in pipes. Its reduction and removal by pipe coverings, separators, traps and drip-return systems.

Use of superheaters and the regulation of superheat. Its effect upon condensation, upon economy and other reasons for its use under special circumstances.

Economical use of steam in the steam engine and turbine. Restricted and free expansion and the work that can be obtained. Incomplete expansion due to too small a cylinder. Limitations due to clearance. Gain obtained by compounding. Complete expansion obtained in the turbine. Principles of reaction and of impulse as used in the turbine.

Typical forms of engine frames, cylinders, pistons, rods, bearings and other parts. Typical forms of turbine casings, nozzles, wheels, buckets, shafts and bearings.

Engine valves and valve gears and engine governors for control and distribution of steam to give desired direction of motion, speed, regulation and economy. Special problems in turbine governing.

Speed oscillations, and their limitation by means of a flywheel.

The prevention of vibrations and excessive stresses by the balancing of parts.

Lubrication of bearings and lubricating systems of the gravity and force-feed types. Some special types of bearings.

Foundations for boilers, pumps, engines and supports for piping to prevent vibration and avoid stresses due to unequal expansion.

The disposal of exhaust steam. Use of vacuum exhaust systems and their relation to power and economy of engine. Surface, jet and barometric condensers. Circulating pumps, hotwell and dry-vacuum pumps, and their regulation. Cooling towers. High vacuum condensers and nonvacuum condensers.

Steam-power plant arrangements to fulfil special conditions of service.

Bursting Flywheel Wrecks Engine

One of the ball springs of a throttling governor on a 125-horsepower slide-valve engine worked out of place and prevented governor from regulating admission of steam. As a result the speed increased until the explosion of the 10-foot flywheel completely wrecked the engine.

The bursting of a 10-foot flywheel of a 125-horsepower slide-valve Atlas engine at the Westport (Md.) Paving Brick Company's plant, so badly wrecked the engine that it is only fit for the junk pile. The engine was used for driving a rotary drier, which dried the clay after it had been pulverized. The accident, which occurred about ten minutes after starting up at the noon hour on Friday, May 6, was due to one of the ball springs of the throttling governor working out of place. This prevented the governor from regulating the admission of steam, with the result that the engine ran away.

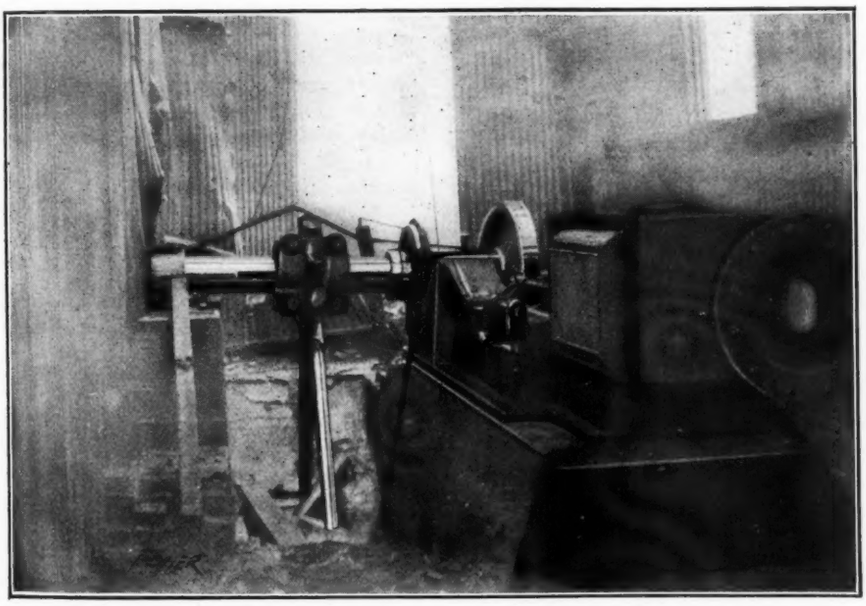


FIG. 1. WRECKED ENGINE FROM CYLINDER END

Pieces of the flywheel crashed through the sheet-iron roof and end wall of the engine room and out through the sheet-iron wall and roof of the mill, one piece landing 300 yards away. The 24-inch rim of the flywheel was broken into a number of small pieces, the largest being not over 4 feet long on one side and 16 inches on the other, as the fracture ran diagonally across the face of the rim on one end and practically square across on the other. The flywheel was made in two pieces and the rim bolted together with four 1-inch bolts at each joint. The bolts held, however. The flywheel had 10 spokes, two of which broke at the rim, and the other eight parted at the hub, as shown in Fig. 1.

The outer pillow block was wrenched from its bedplate, breaking through on both sides of the bearing. The bedplate was also forced out of place and a piece broken out of one side, allowing the bearing to swing toward the cylinder end of the engine.

The main pillow block was completely demolished, breaking away at the bottom of the outer box jaw and taking the entire outer end of the box bed of the engine with it. This is shown in Fig. 2. The bearing cap on the side of the bearing that gave way held, but broke through the bolt holes on the cylinder end of the frame. The end of the engine bed and the broken bearings were thrown clear of the frame.

Although the crank end of the connecting rod was made up of a three-part strap, the upper and lower sections being bolted to the end piece, three bolts passing through all, it held. The end piece, in this instance, was merely turned a trifle, which would indicate that the pin used to prevent it from turning had been sheared. The projecting sides of the brasses were considerably bent where they lapped over the crank-rod end. The eccentric rod gave way at the pin bearing of the guide end of the valve stem, breaking at the oil hole.

The engine will be discarded and the power necessary to run the drier taken from a large engine driving other machinery in the mill. Fortunately, no one was injured.

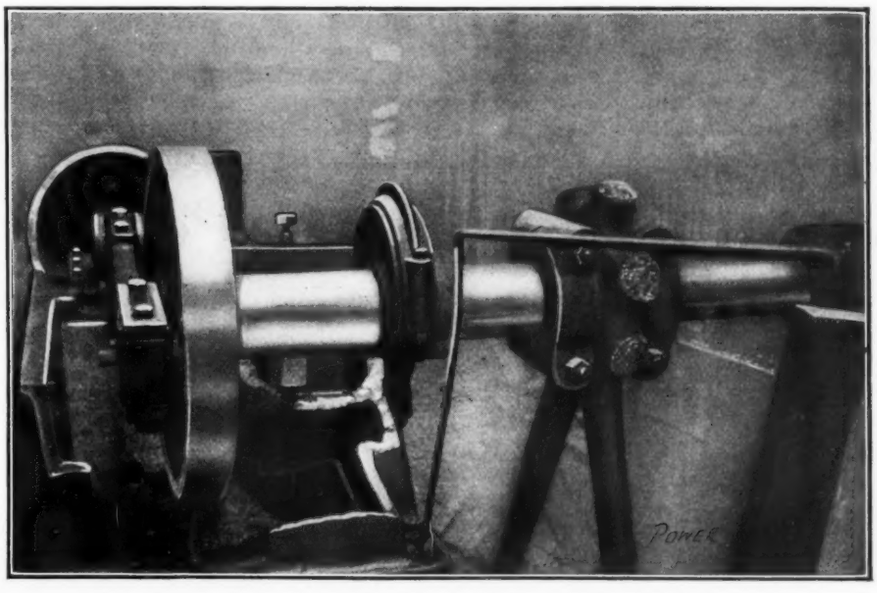


FIG. 2. SHOWING WRECKED PILLOW BLOCK, FRAME AND FLYWHEEL

Iowa N. A. S. E. State Convention

The seventh annual convention of the Iowa State National Association of Stationary Engineers was held at Waterloo, May 6 and 7, 1910. The convention was remarkable for the interesting papers presented and the interest taken by all in the furtherance of the affairs of the association. C. M. Larson, of the Union Electric Light Company, of Dubuque, presented a comprehensive paper on the steam turbine. Beginning with the definition of the different principles upon which turbines are designed, he followed with a description of the different types, including the De Laval, Westinghouse-Parsons, Allis-Chalmers, and Curtis, bringing out the peculiar characteristics of each make, their advantages and disadvantages. The paper was illustrated with comprehensive sketches and charts, and was thoroughly appreciated by all.

"Boiler Feed Waters and What They Contain" was the subject of a paper by W. A. Converse, of the Dearborn Drug and Chemical Company. In this paper, Mr. Converse took up the constituents commonly found in feed water, showed why they caused trouble and demonstrated the system for removing these constituents for the purpose of analysis. His paper was supplemented by a complete system of laboratory apparatus for accomplishing all the reactions and it was shown that once the characteristics of the principal impurities of feed water were known it would be a simple matter for the engineer himself to remove them, making his own analysis with the aid of a few pieces of apparatus and a little study.

The hospitality of the citizens of Waterloo was shown to be of the highest class. City Solicitor Kelley welcomed the organization to the city. F. E. Cutler, president of the Commercial Club, was a leading spirit in the entertainment and spoke at the opening exercises. F. W. Raven, national secretary, and John E. Kerley, national trustee, were present and addressed the convention on matters relating to the national organization.

At the banquet held at the Ellis hotel, Friday evening, the speakers were Michael Kelley; John Kerley, national trustee; A. C. Wilford, State president; J. S. Doolittle, State deputy; J. A. Welzenbach; F. E. Cutler; W. A. Converse and Frank E. Newkirk. F. W. Raven, of Chicago, acted as toastmaster.

The license committee reported on progress during the year and suggested that the endeavors of the association should be directed toward the establishment of city laws rather than toward a State law at the present time. It was pointed out that once the cities were won over to the idea, it would be easier to get legislation covering the entire State.

Officers for the ensuing year were elected as follows: H. T. Yust, president, Ottumwa; S. C. Dyke, vice-president, Dubuque; George H. Beebe, treasurer, Marshalltown; James A. Coulson, secretary, Sioux City; James L. Rockwell, conductor, Sioux City; William D. Ryan, doorkeeper, Waterloo. The new officers were installed by F. W. Raven and John Kerley. Ottumwa was chosen as the next place of meeting.

There was an unusually complete line of exhibits in the exhibit hall, at the Ellis, the firms and representatives being as follows:

Albany Lubricating Company, New York, George A. Wellington.

American Steam Gauge and Valve Manufacturing Company, Boston, Charles C. Kilander.

American Steam Pump Company, Battle Creek, Mich., Charles M. O'Brien.

Anchor Packing Company, Philadelphia, J. B. Philip and W. E. Elphick.

Crandall Packing Company, Elmira, N. Y., W. F. Ebert and J. H. Vailes.

Dearborn Drug and Chemical Company, Chicago, W. A. Converse, F. C. Gibbs, O. E. Poole.

Engineering Specialty and Machine Company, Omaha, J. B. Philip.

Fisher Governor Company, Marshalltown, Ia., George H. Beebe, R. B. Reasoner.

Garlock Packing Company, Palmyra, N. Y., H. W. Irons.

Globe Machinery and Supply Company, Des Moines, Ia., W. S. McMichaels.

Greene, Tweed & Company, New York, Joseph Williams.

Hartford Steam Boiler Inspection Insurance Company, Hartford, Conn., G. M. Turney.

Hawkeye Boiler Compound Company, Chicago, R. L. Robinson.

Hunt Commutator Truing Machine Company, Eagle Grove, Ia., O. E. Hunt.

Jenkins Brothers, New York, Joseph Williams.

Johns-Manville Company, Milwaukee, Wis., C. S. Paggett.

Keystone Lubricating Company, Philadelphia, T. W. Armstrong.

Lyons Boiler Works, De Pere, Wis., W. P. Lyons.

Leighton Brothers Supply Company, Ft. Dodge, Ia., H. Shields.

Lunkenheimer Company, Cincinnati, O., E. P. Gould.

McMaster-Carr Supply Company, Chicago, R. H. Rawson.

Morehead Steam Trap Company, Detroit, Charles Menges.

POWER AND THE ENGINEER, New York, O. Monnett.

Practical Engineer, Chicago, R. E. Turner.

William Powell Company, Cincinnati, Charles Menges.

Quaker City Rubber Company, Philadelphia, H. E. Dennie.

Standard Oil Company, New York, F. A. Whitney, F. M. Williamson.

Scott Valve Company, Chicago, Charles M. O'Brien.

Teller Air-Burning Furnace Company, T. C. Teller.

Under Feed Stoker Company of America, Chicago, S. S. Howell, C. K. Sherman.

Viscosity Oil Company, Chicago, E. R. Stubbs.

Western Valve Company, Chicago, Q. T. Stewart.

Western Boiler Compound and Chemical Company, Kansas City, F. J. Deedy.

C. B. White & Co., Chicago, C. B. White.

Limit to Water Power at Niagara

A treaty has been signed by Great Britain and the United States in which provision is made for regulating the use of water for power purposes at Niagara falls. By the terms of the treaty the Canadian side is to be permitted the use of 36,000 cubic feet per second, while the New York side will be allowed to use 20,000 cubic feet per second. The amount allotted to the Canadian side will make possible a much larger development than is now in use, but as the developing companies are permitted by the Canadian authorities, as well as by the United States authorities, to transmit and sell in the United States at least half of the power generated in Canada, the New York side is benefited by the Canadian development.

The 20,000 cubic feet allotted to the power companies on the New York side will make it possible for the Niagara Falls Power Company and the Niagara Falls Hydraulic Power and Manufacturing Company to perfect their developments as originally planned. It will also leave a small amount of water for use in Lockport, where one company has a development to effect which water is diverted from the Erie canal. As considerable attention is paid to efficiency at Niagara, on both sides of the river, the water diverted may be expected to afford the highest possible results in power output that can be obtained with modern equipment.

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May 3	36,000
May 10	36,000
May 17	35,500
May 24	35,000

None sent free regularly, no returns from news companies, no back numbers. Figures are live, net circulation.

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Power and The Engineer

Editorial

The Institute of Operating Engineers

The announcement of the intended organization of the Institute of Operating Engineers has been received with a great deal of interest and the demand is keen for more detailed information. Just what form the organization will take is for the united wisdom of its founders to determine; and its founders are still to be found. You may be one of them if you will. All that has been done as yet is that a number of engineers who recognize the necessity for and the possibilities of such an Institute have effected a provisional or temporary organization to bring it about. Those who are interested to see this done recognize that the movement must be universal. No group of engineers can get together in New York, organize such an institution and then invite the nation in. They would like to see every engineer in the country, on the continent, interest himself in it, become a part of it, and be present or be represented by proxy at the convention which will determine its form and shape its policies. If it were possible, such an invitation would be sent to everybody who would be likely to be interested; but this is impossible, because even if the committee knew every man who ought to be interested the means are not available for sending out the thousands of letters which would be required. It is hoped, therefore, that everybody who feels that such an Institute would be a good thing for operating engineers and for operative engineering, and who is willing to become a part of it and to help it along, will write to M. W. Rice, secretary of the provisional organization, Engineering Societies' building, 29 West Thirty-ninth street, New York City, and get into touch with the movement.

The Institute as conceived by its proposers comprises the following grades: Members, associates, junior members, journeymen and apprentices, and offers a place for every responsible operating engineer or aspirant for that position, whatever his age, experience or attainments. The young man who is just starting out registers with an individual Institute member or with a local branch of the Institute as an apprentice. A course of study is indicated which he must follow in connection with his practical work. He may do this by himself, in evening schools, by the correspondent-school method, in the most available manner. It does not matter how he gets it so long as he acquires the knowledge necessary to the next higher grade. This knowledge, besides the arithmetic, etc., especially requisite for the engineer, comprises the essentials of an ordinary grammar-school education. Having proved by application, industry and stability his earnestness and fixedness of purpose, he can at the age of twenty, providing he can satisfy his sponsor and the Institute that he has served the necessary time with credit about a steam plant, machine or boiler shop, receive the Institute apprenticeship certificate, indorsing him as a journeyman machinery operator or fireman and qualifying him to become a journeyman member.

Entering the Institute at twenty or over as a journeyman, a young man is given a further course of study which he must complete before he can be admitted to the higher grade. Here again the curriculum is not confined to strictly engineering topics. If the vocation is to be maintained upon a high plane, it is essential that its members shall possess some degree of culture, shall be able to meet educated people upon their own plane, shall see the world from some other point of view than that of the coal pile, shall be able to talk something besides "shop," shall be in touch with life in more than a single spot. For the many engineers who are located where they are available, efforts will be made to take systematic advantage of the facilities for technical instruction offered by such institutions as the Franklin Union at Boston, the Lewis Institute at Chicago, the Carnegie Institute at Pittsburg, the Mechanics' Institute, Cooper Union, Pratt Institute, Brooklyn Polytechnic, Columbia College extension courses, etc., at New York. Where no such institutions exist, classes can be organized, although perhaps to less advantage than where laboratory facilities and trained educators are made available to the working man after working hours. Efforts will be made, however, by the Institute toward the inclusion in their curricula by evening schools, Y. M. C. A. branches and the numerous other public and private institutions which now offer opportunities to the man who must earn as he learns, of courses in line with its work and assurances have been received from prominent educators and officials that this would be done.

After the graduate journeyman has attained the age of twenty-three years, has had the prescribed amount of experience, and acquired the necessary degree of education, he may be awarded the diploma of operating engineering and become a junior member. It is not necessary that one shall have passed through the apprenticeship degrees to become a journeyman, nor in fact through any lower degree to attain a higher. He may enter any degree for which he is qualified in age, experience and education, however and wherever those attainments have been acquired. The ruling principle right through is that it is present worth which counts, whether a man gets his equipment with his father's money in an Institute of Technology, or by his unaided efforts over the kitchen table after a hard day's work. And the hard day's work is as necessary a part of the equipment as the book lore. Actual experience in the plant will be absolutely insisted upon, which rules out the graduate with nothing to recommend him but a pair of gold spectacles and a slide rule as effectually as it rules out the mere hand laborer.

After the junior member has attained the age of thirty, has seen the necessary service, learned the things considered essential and is in actual charge of plant and men, either as chief or first assistant engineer, he may apply for a certificate of full membership, and it is the object and hope of the promoters of the Institute to make the bestowal of this certificate—authorized by its charter—in effect the conferring of a degree in the school of experience and self-instruction. This certificate will be an avowal by a high-toned disinterested scientific educational organization, incorporated and chartered for that purpose, that the holder is a thoroughly equipped master operating engineer, competent to take responsible charge of steam plants, that he has certain educational attainments and is entitled to the consideration that gentlemen who have scaled the same hights against the same obstacles are accustomed to give to each other.

The worth of this certificate will be determined by the first one hundred holders of it. If the first one hundred could be awarded to men who stand undoubtedly and admittedly at the head of the vocation; to men whose experience, attainments, personality and habits are such as to command respect for their vocation, as well as for themselves, and the Institute could say, "It is of such as these that you must be who wish to join us," the success of the plan would be assured. The instant there is any weakness in this respect, the instant the man is admitted who falls below the high standard which is here to be set for the fully equipped operating engineer because he is a good fellow, or because his feelings must be spared, the whole project has begun to sink. The high standard must be set, the unsuccessful candidate must be shown in what respect he fails to fulfil the ideal, and encouraged to make good his deficiencies or correct his faults.

And right here comes the critical question. Who is going to do this? Who is going to single out the elect, and say who is and who is not admissible? It must not be done in such a way as to establish an aristocracy, an oligarchy, an exclusive mutual-admiration society. There must be no portal that real worth will not open, no circle into which he who is duly qualified, however he became so, may not penetrate. The solution is to have a rigid standard and to live up to it, welcome every man who can fill the specifications, and encourage those who fail to try again. What the requirements shall be, whether compliance with them shall be determined by an examination, an investigation of one's record, the submission of a thesis or in whatever way, it is for the convention to determine and you can come in now, and your voice and vote will have the same chance to be heard and counted as another's in determining who shall be members and how they shall be classified.

An unnecessarily alarmed contributor to the columns of a journal devoted to labor interests has characterized the Institute as a "Scab Hatchery," a very natural conclusion of one who had not grasped the idea, and saw in it only a school to turn out engineers to take the places of his fellow members. The man who will follow out the program outlined above in order to become an operating engineer would probably become one anyway. By identifying himself with the Institute his efforts are more intelligently applied and directed and when he gets through he is up in the quasi-professional class and has something to show for it. The movement has the expressed approval of a number of the most intelligent and thoughtful among the labor leaders, and the only fault which a radical laborite could find with it is that it tends to the establishment of caste among engineers. Inasmuch as "the engineer" may be anything from a laborer who gets a dollar a day and has to have a mark on the gage because he cannot read the figures, up to the man who designs and is responsible for the operation of a hundred-thousand-kilowatt station, it is time there were some classification or caste put into the vocation, and it is a part of the object of the movement to make the word "engineer" mean something and to pitch that meaning high.

There is no reason either why the movement should invite opposition on the part of the leaders of such fraternal and other organizations as now exist in the vocation. If it overlaps them at all it is in the educational work which in few if any of them takes the form of a definite course of study leading to a definite end. The aim, purpose and scope of the Institute are entirely different. One might as quickly expect opposition from the local lodge of Odd Fellows to the establishment of a college extension course.

The Institute will occupy the same position toward the vocation of the operating engineer that the national societies of civil, mechanical, electrical and mining engineers do toward those professions. The location of the offices of the preliminary organization at the United Societies building, the home of three of the national professional societies above mentioned and the professional engineering center of the continent, is an earnest of its high aims and purposes and of the high character and ideals of the men who have it in charge. It is worthy of the support and attachment of the best men in operating engineering, and offers to the beginner the surest, safest path to the top. Carried out upon the proposed lines it would be a greater implement for pulling the operating engineer and operative engineering out of the slough into which they have drifted than anything which has been conceived. Its projectors are practical, whole-hearted, clear-headed men who have been through the mill and realize the needs of the situation. Write to M. W. Rice at the address given above and find out more about it. Or better still, send him your five dollars, become a charter member and help the movement get upon its feet. Then go to the convention or select someone in whom you have confidence to act as your proxy in building for it a foundation which will bear it through years of usefulness and a development which no man can foretell.

Automatic recording instruments, for measuring pressure, temperature, speed and quantity, as well as for making gas analyses, are growing in favor. It is being discovered that there is profit in knowing the facts. Recording instruments are a cheap means of securing, for reference and comparison, valuable data about power-plant operation and the performance of power-plant apparatus.

When it comes to gaining notoriety the engineer who begins adjusting his engine before he knows what he is doing will hold his own.

Engineers frequently work themselves out of a good job trying to see how little work they can do.

Many an obscure engineer, by neglecting to give proper care and inspection to the boilers in his care, has been blown into prominence.

An oiler should always remember that a drop in time saves trouble.

Inquiries of General Interest

Questions are not answered unless accompanied by the name and address of the inquirer. This page is for you when stuck—use it.

Shutting Down an Alternator

What is the best way to shut down one of several three-phase generators operating in parallel?

M. K.

Reduce the power of the engine driving the generator to be shut down until it is taking a very small proportion of the total load on the busbars, keeping the field fully excited; then pull the main switch quickly. Shut down the engine and, while it is coming to rest, reduce the field strength of the generator as much as the rheostat will do so; then open the switch in the field circuit.

Boiler Tubes and Hot Gases

Why is it safe to expose the upper part of the tubes of a vertical boiler to the heat from the furnace gases while in a horizontal boiler the tubes must be covered with water?

A. P. L.

In a vertical boiler the submerged portion of the tubes absorbs the heat of the passing gases so rapidly that when the water line is reached they are not hot enough to do any damage.

In the horizontal boiler but a small part of the heat is transmitted through the shell to the water and the gases enter the tubes at such a high temperature that if the tubes were not covered with water the heat would soften them so that they would collapse from the pressure.

Reasons for Bridgewalls

What is the object of the bridgewall in steam-boiler furnaces?

F. C. H.

Its chief utility consists in forming a fence or barrier over which it is difficult for the fireman to pitch fresh coal or to push a part of the fuel bed when working the fire.

It has been stated that a combustion chamber is formed back of the wall in which air and the unburned gases may mix and burn, but the hight of the wall above the grates seems to have little influence on combustion.

Motoring of a Shunt-wound Generator

If the engine driving one of several shunt-wound dynamos should be shut down while the machine is still in parallel with the others, what will happen?

T. G.

The machine will run as a motor in the same direction as usual, driving the engine; the speed will be 10 to 20 per cent. below normal, according to the resistance of the armature circuit and the current required to drive the idle engine.

Gasolene Engine Compression

If the volume swept out by the piston of a gasolene engine in one stroke is 210 cubic inches, how many cubic inches should the clearance or combustion chamber have to raise the pressure to 75 pounds above atmospheric at the end of the compression stroke? What is the rule?

R. W. F.

The clearance should have about 69 cubic inches. You can figure the clearance roughly as follows: Divide the desired absolute compression pressure by 14; find the cube of the quotient and take the fourth root of that; this result will be the approximate "compression ratio." Subtract 1 from the ratio, divide the piston displacement by the remainder, and you will have the approximate clearance volume. You will find tables and rules for this kind of work in an elementary book called "The Gas Engine," by Cecil P. Poole.

Changing Speed of Engine

I wish to increase the speed of an automatic engine having a centrifugal governor. How shall I proceed?

M. H. B.

Slight changes in the speed may be made by shifting the position of the weights, by a change in the spring tension, or by both together. Moving the weights where movable weights are used toward the point of suspension will increase the speed, and moving them in the opposite direction will decrease it. Increasing the spring tension tends to increase the speed of the engine. For any considerable change in speed, the weights and the springs should both be changed.

Clearance and Keying

If keying the connecting rod alters its length, how does this affect the clearance?

M. G.

If keying shortens the rod it brings the piston nearer the crank end of cylinder, reducing the clearance at this end of the cylinder and increasing it at the other. If, as is the case with some types of rod ends, keying increases the distance between the crosshead and crank pins, the reverse occurs.

Coal or Wood Fuel

Which is the cheaper fuel, coal or wood?

H. A. D.

It depends on prices and furnace conditions. Two and one-half pounds of dry wood has about the same heating capacity as one pound of coal. If the wood is green or only partially seasoned its heating value is low.

Temperature of Melting Babbitt Metal

In melting babbitt metal, how can I tell when it is hot enough to pour?

N. A. H.

When melting it should be stirred occasionally with a pine stick and should be heated no hotter than to slightly char the stick.

Bending Brass Pipe

How can I bend 1-inch brass pipe for a hand-rail without flattening or kinking it?

Z. A. C.

Cut from a 2-inch plank a form the shape of the desired bend. Cut a half-round groove in the edge of the form that the pipe will just fit. Stop one end of the pipe and fill it with melted resin. Clamp the pipe securely to the form where the bend is wanted. Fasten the form to the floor or to a convenient column or pillar in the building and with a block and tackle or small chain hoist draw the pipe slowly to the curvature of the form. After bending, the resin may be melted and allowed to run out. Dry sand is frequently used in the place of resin for filling the pipe before bending and is equally satisfactory if the pipe is properly filled. If sand is used it should be nearly, if not quite, red hot when put into the pipe.

Atmospheric Pressure Above the Sea Level

If the atmospheric pressure at the sea level will support a column of water 34 feet high, what will be the hight supported at 12,000 feet above the sea level?

C. P. F.

The pressure of the atmosphere decreases approximately one-half pound per square inch for each 1000 feet of altitude. At 12,000 feet above the sea level the air pressure is nearly

$$14.7 - 6 = 8.7$$

pounds per square inch, and the hight of the column of water which the air pressure will support bears the same relation to 34 feet that 8.7 bears to 14.7, or 21.12 feet.

New Power House Equipment

Combination Water Tube and Return Tubular Boiler

What the inventor and the manufacturer are doing to save time and money in the engine room and power house. Engine room news.

W. D. Plue, of Rainier, Ore., has recently designed and patented the boiler illustrated and described herewith.

It is a combination of the water- and fire-tube boilers, as shown in Fig. 1. The return-tubular feature consists of a regular design of return-tubular boiler, with the exception that the front sheet is cut away on the bottom for an opening into the water leg, which is riveted to the front end of the boiler shelf, as shown in Figs. 1 and 2. This water leg

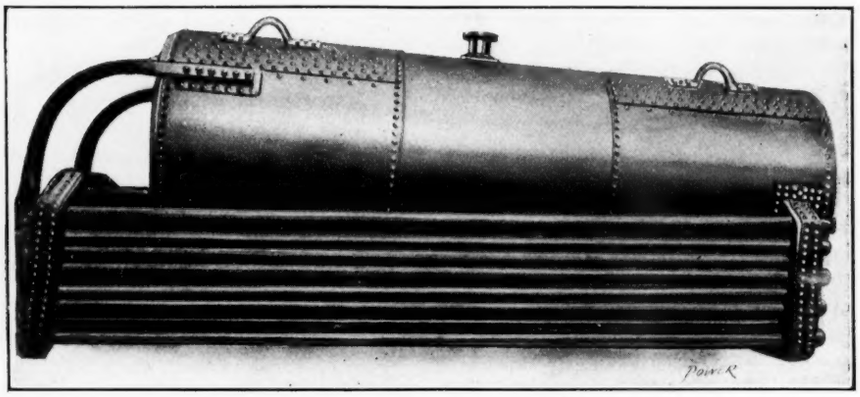


FIG. 1. COMBINATION WATER-TUBE AND RETURN-TUBULAR BOILER

or tube header extends up part way on each side of the boiler. Fig. 2 shows how the water tubes are spaced, also their slant toward the rear end. The

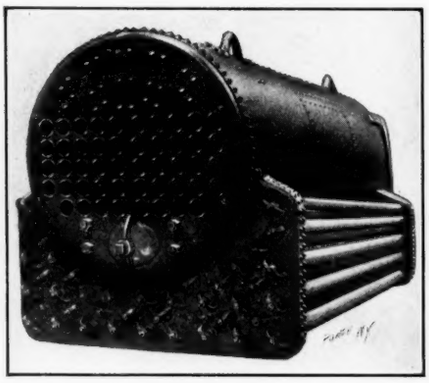


FIG. 2. FRONT TUBE HEADER

tubes are expanded in the inner sheet of the tube headers. The rear header is not riveted to the shelf, but is suspended from two arms, one on either side, as shown in Fig. 3. This is accomplished by riveting one end of each bent arm to the outside plate of the rear water leg and the other end of the boiler shell.

A connection is made between the rear water leg and the boiler head by ten circulating tubes, thus providing for the free circulation of the water from the water tubes to the shell section of the boiler. These tubes are accessible through the handholes shown at the top of the water leg in Fig. 3. The furnace is constructed under the end of the boiler to which the water leg is riveted. Baffle walls built in among the water tubes force the flame and hot gases to cross and recross them

FIG. 3. REAR TUBE HEADER

three times in passing over their entire surface. Then the hot gases enter the fire tubes, pass to the front of the boiler and escape to the smoke flue.

The boiler is accessible for both internal and external cleaning. It is possible to clean the water tubes from either end, on the inside as well as on the outside. The interior of the tubular section is cleaned in the ordinary manner. The shell is provided with two manholes, one above the tubes in the rear head, and the other below the tubes in the front head.

The entire boiler is suspended from an I-beam frame, by means of suspension bolts engaging with four straps riveted to the boiler shell.

Bayer Steam Meter

This recording steam meter depends for its operation essentially upon the displacement of a disk in a conical tube, by the steam pressure acting against a counterweight. The steam thus holds

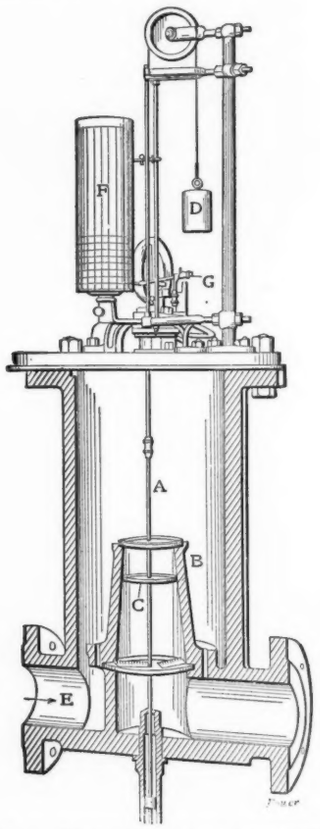


FIG. 1. SECTIONAL VIEW OF BAYER'S STEAM METER

open for its own passage an annular space around the disk, greater or less according to the force exerted for the time being.

The weight of steam passing through an aperture is the product of three factors: the area of the passageway, the velocity of the steam and the weight of a unit's volume of the steam at its mean pressure. These three factors multiplied together give the desired result. Fig. 1 shows a sectional view of the meter.

Steam enters through *E* into the cham-

ber *A*, and in order to pass out to the place where it is utilized must pass through the hollow cone *B* around the edge of the disk *C*, which is suspended by a wire and overbalanced by the counterweight *D*. The greater the downward force of the steam, the larger the opening it will make for itself around *C*. This opening is recorded by a pencil on

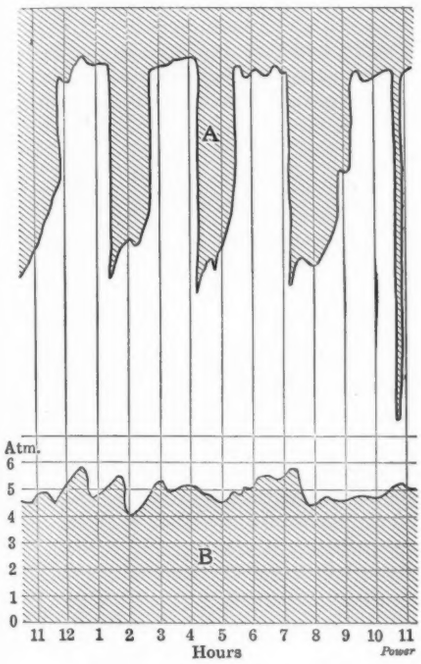


FIG. 2. DIAGRAMS FROM METER

the upper part of the continuous-motion indicator drum *F*. Another pencil *G* is connected with a pressure gage or manometer and traces on the lower part of the drum *F* another line corresponding with the aperture diagram in intervals of time.

The diagrams thus traced are illustrated in Fig. 2. With the aid of a planimeter the mean hight of the upper curve *A* is obtained, which gives the mean area of opening. The mean specific weight is derived from the mean pressure, which is obtained from the pressure-gage diagram *B*. The velocity bears a known relation to the specific weight. Thus the three factors necessary to determine the average steam consumption per second are obtained.

To avoid the necessity of calculation every time a reading is made, a table has been prepared by which the steam consumption may be read direct, after determining the mean area of opening and mean pressure.

The diagram shown in Fig. 2 runs from eleven o'clock in the morning to eleven in the evening. It plainly indicates five periods of work with the steam, the last one brief and intense.

The meter not only records the steam consumption, but enables the manager to keep watch over the performance of his employees and thus to avert waste of steam.

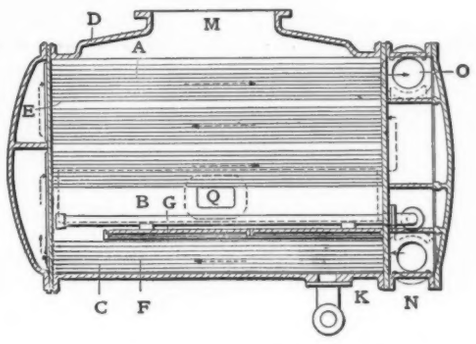
This meter is made in two sizes which serve both for saturated and superheated steam of from 14.7 to 175 pounds pressure, corresponding to a maximum steam quantity of 600 to 1400 and 1132 to 2800 pounds per hour.

Larger meters sacrifice an important advantage, namely, control of steam consumption by individual appliances. The makers, however, construct a larger size than those mentioned, having a maximum capacity of 5454 pounds per hour at 175 pounds pressure.

The manufacturers of this instrument are Farbenfabriken vorm. Friedr. Bayer & Co., Elberfeld und Leverkusen b. Mülheim a. Rhein, Germany.

Combined Surface and Jet Condenser

A design of condenser in which the principles of the jet and the surface types are combined and for which an improved



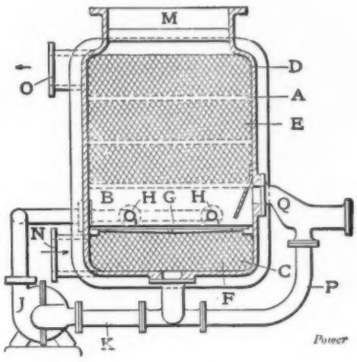


FIG. 1 COMBINED SURFACE AND JET CONDENSER FIG. 2

vacuum is claimed was recently described in the *Mechanical Engineer* of London. The apparatus has been designed by the Warwick Machinery Company, Limited, 83 Cannon street, London, E. C., and F. Samuelson. It comprises a casing *D* divided into three parts *A*, *B* and *C*, Fig. 1, the upper and lower parts *A* and *C* being provided with banks of tubes *E* and *F* respectively, through which a cooling medium is circulated. The middle portion *B* of the casing has no tubes, but is provided with a plate *G* upon which are supported a number of longitudinal spray tubes *H*, Fig. 2. These tubes are supplied with water by a pump *J* which draws its supply through a pipe *K* from the lower part of the condenser casing. This water is forced into the space *B* in the form of a fine spray and falls with the freshly condensed water on to the plate *G* which is so fixed as to cause it to run to the left in Fig. 1, falling off the plate on to the bank of tubes *F*. After falling off the plate it has to pass through between the tubes toward the right to the outlet.

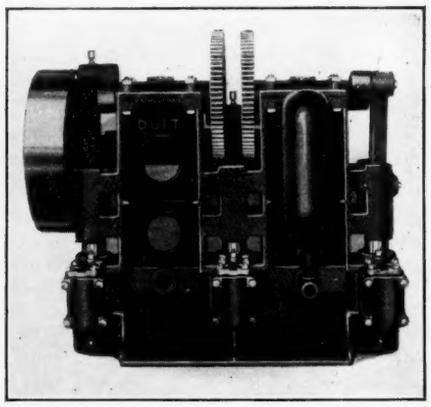
The operation is as follows: Exhaust steam enters at the condenser inlet *M*. The cold water or other condensing medium enters at *N* and passes and repasses through the tubes *F* in the directions indicated by the dotted arrows to the outlet *O*. It will be seen that the incoming steam passing downward meets the water passing upward and is to a large extent condensed thereby. The condensed water falls on the plate *G* and thence on to the tubes *F* where it is cooled by contact with the tubes. Some of the water of condensation is then drawn off by the pump *J* and returned to the condenser, issuing from apertures formed in the tubes *H* in the form of a fine spray which mingles with and condenses the steam which has passed downward through the upper bank of tubes *E* without being condensed and effectively cools the air vapors present. The remainder of the condensed water is withdrawn from the condenser through the pipe *P* which is connected to a wet-air pump, not shown. This pump is also connected to the interior of the condenser by a conduit *Q* which communicates with the portion containing the spray tubes, so as to enable the air pump to remove the air and steam vapors from the condenser in the usual way.

The Duit Triplex Pump

A triplex single-acting pump which is remarkably self-contained and embodies many desirable features has recently been designed by the Lucas Pump Company, Dayton, O., and is now being built in capacities up to 60 gallons per minute, for all pressures not exceeding 200 pounds pressure. These pumps are especially adapted to furnish the water supply in mills, factories and office buildings; to be used in connection with hydraulic elevators or for boiler feeding.

In construction the entire main casting of the pump, including valve chambers and cylinders, is in one piece, which secures unusual strength and rigidity for hard service. The crank shaft, as apparent in the accompanying illustration, is driven from the middle by a pair of gears, which enables the crank shaft to be built unusually strong for the service and requires only two bearings for the

three plungers. The gear ratio is 5 to 1, with an equal drive on each side of the pin; the gears are machine cut. Ample oil pockets are provided in the main bearings, enabling the pump to be run continuously for long periods without attention. The guides, which are cast integrally with the frame, are accurately bored and the crossheads babbitted, which enables repairs to be made by removing the crosshead and finishing on a lathe away from the pump in the most convenient manner. The plungers



DUIT TRIPLEX PUMP

are of cast iron and are brass-covered when desired. The valve chambers on each side of the pump are all connected by a waterway cast as part of the frame, and each valve chamber covers the opening from this waterway at each cylinder.

One suction and one discharge valve are used with each plunger. These valves are of metal with rubber facings suitable for the liquid to be pumped. They are guided by projections into the valve cap and have ample movement. The valve seat is a clear opening made as part of the valve-chamber casting. This gives a large area with no grids or cross pieces to obstruct the movement of the liquid. When desired, the water chambers in the pump may be blocked off separately in the main frame casting and the pumps used on entirely independent circuits; thus two plungers might be used for general water service and the remaining plunger for boiler feeding. These pumps are said to be finding considerable application in connection with sprinkler systems.

Norway abounds in waterfalls, the water supply being quite constant throughout the year, partly owing to the altitude of the water sources, the condition of the climate, and the exceptionally high rainfall. The total water power of Norway amounts to about 7,500,000 horsepower, giving 3405 horsepower per 1000 inhabitants of the country.

The Superior Pebble Phosphate Company, at Mulbury, Fla., has a plant of 14 Diesel engines running on Texas oil.

Improved Lagonda Feeding Device

This feeding device was illustrated and described on page 620, of the March 30, 1909 issue of POWER, but has since been changed in that the guide rolls have been removed, so that it is now possible to withdraw the turbine cleaner from the boiler at any time, which aids in renewing the cutters on the cleaner head with sharp cutter wheels without much loss of time. This improved feeding device is manufactured by the Lagonda Manufacturing Company, Springfield, Ohio.

Vater Open Feed Water Heater

This heater is manufactured by the Power Plant Specialty Company, Chicago, Ill. The shell is made of ½-inch steel plate, on the inside of which angle irons are riveted, and support cast-iron trays. These trays, over which the water flows, have serrated lips, top and bottom, which insure an even distribution and breaking up of the water into fine particles. The feed water enters the heater through the top connection, as shown in Fig. 2, the supply being regulated by a seamless copper-ball float, link and levers. The float ball is secured to

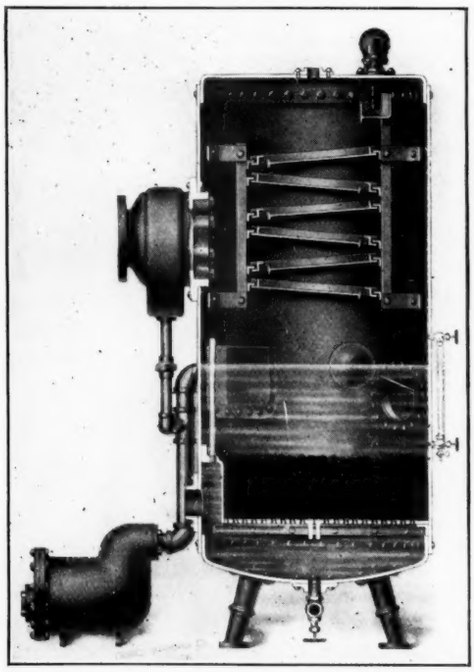


FIG. 1. SECTIONAL VIEW OF VATER OPEN HEATER

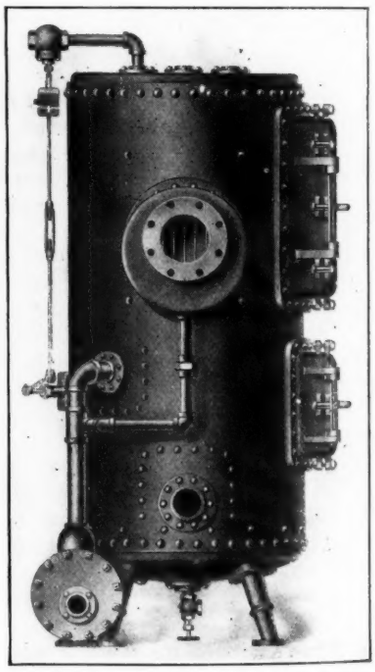


FIG. 2. EXTERIOR VIEW OF VATER OPEN HEATER

a hollow float stem and shaft, so that if the float deveops a leak, the water, coming from the hollow shaft, acts as a telltale. The entire float mechanism may be removed by unscrewing six cap screws.

The regulating valve on the inlet pipe is balanced, and the weight of the float, rod and connections is counterbalanced. The valve is regulated by outside adjustment. The return water is brought into a distributing water box, which forms a water seal and prevents water hammer. The water flows from this distributing box over the trays and is heated as the steam mingles with it. The exhaust steam enters the heater after passing through a two-stage oil separator, shown attached to the side of the heater. Because the drip pipe of the separator is placed outside of the heater, no oil, after being separated from the steam, can get into the heater.

The heated water falls to the bottom of the heater, but before entering the suction pipe of the feed pump is forced to pass through the filter bed to the suction hood shown in Fig. 2, which prevents the pump drawing out deposits of sediment. The suction hood is provided with a vent to insure a solid body of water going to the feed pump. The heater is fitted with a skimmer, shown behind the suction-hood vent pipe, by which light, floating impurities can be flushed out of the heater.

The body of the filter is fitted with a top vent and a blowoff outlet, located at the lowest point possible and in such a position as to be easily accessible.

The doors of the heater swing on hinges, as shown in Fig. 1. Both doors and frames have machined faces and are easily packed. They are held in place by bolts which fit in slots cast to the frame and door, and are removable after slacking one nut on each bolt. The heater is piped to a trap by means of an overflow pipe, which permits of carrying a back pressure on the heater. The heater is made in both vertical and horizontal types; the vertical type is set on suitable legs, while the horizontal type is supported on brick piers.

NEW PUBLICATIONS

DRAWING INSTRUMENTS. By Walter D. Stephan. McGraw-Hill Book Company, New York. 111 pages, 4¾x7¼ inches. Price, $1 net.

On first thought one would not suppose that a book of over 100 pages could be written on so familiar a subject as drawing instruments unless much that was superfluous, irrelevant or trivial was included. After one reads over Mr. Stephan's effort on the subject, however, such a supposition would need revision for he accomplished the feat successfully.

The essentials of good instruments are specified and valuable hints are given of practical tests to apply for quality and accuracy when purchasing instruments. The chapter on the slide rule is too brief. More attention could have been given to this valuable instrument with good advantage. The universal drafting machine does away with T-squares, triangles, scales and protractors. By its use greater speed and accuracy are obtainable. The author gives considerable attention to this device.

The last chapter of the book is on drafting-room practice. In it is given information concerning drawing sizes, hints on the indexing and filing of drawings and practical suggestions relative to the proper execution of drawings.

FUELS AND REFRACTORY MATERIALS. Second Edition. By A. Humboldt Sexton. D. Van Nostrand Company, New York. 364 pages, 4½x7 inches. Price, $2.50 net.

The first chapter, on the subject of combustion, is comprehensive and clear. The subject is presented in language which is as readily understood by the layman as by the student.

In the second chapter, devoted to the heating power of fuel, there is a slight inaccuracy in the statement that the British thermal unit is the amount of heat required to raise one pound of water one degree Fahrenheit (60 to 61 degrees Fahrenheit). The British thermal unit is that amount of heat required to raise the temperature of one pound of water from 39 to 40 degrees Fahrenheit. In the same chapter on page 36, in a footnote, the grammatical error is made of using a singular possessive pronoun when referring to a plural subject.

The chapter dealing with the physical and chemical properties of fuel are extensive as are those which treat of the methods employed in making prepared fuels, such as charcoal, coke, oil and gas. Many types of gas producers are considered.

Thirty-eight pages are devoted to pyrometry. About 20 makes of instruments are described. The chapter on this subject is overelaborate for a book of this kind. Fuel calorimeters receive 12 pages of consideration. For some unknown reason flue-gas analysis is not given any attention.

Refractory materials, firebrick and crucibles are disposed of in 28 pages. Methods of manufacture of brick and crucibles are described and the properties of the materials are given.

This book should be valuable to all interested in securing a knowledge of fuels and their combustion.

Boiler Explosion at Chewtown, Penn.

It is reported in the daily papers that on May 15 a battery of five boilers in the plant of the Diamond Coal and Coke Company, Chewtown, Penn., exploded, killing three men and injuring six others. Details of the explosion will be given in an early issue.

BOOKS RECEIVED

"American Producer Gas Practice." By Nisbet Latta. D. Van Nostrand Company, New York. Cloth; 540 pages, 7¼ x10½ inches; 247 illustrations; tables; indexed. Price, $6.

"The Corrosion and Preservation of Iron and Steel." By Allerton S. Cushman. McGraw-Hill Book Company, New York. Cloth; 363 pages, 6x9 inches; 69 illustrations; tables; indexed. Price, $4.

PERSONAL

Ludwig A. Kemper recently resigned from the position of manager of the Albert Lea Light and Power Company, Albert Lea, Minn., to become associated with the engineering staff of the Fuel Engineering Company, of Chicago.

Robert Wetherill Jr., has been appointed manager of the recently opened New York office of Robert Wetherill & Co., Inc., of Chester, Penn., manufacturers of Corliss engines, boilers, etc. This office is located at room 2053 Hudson Terminal building, 50 Church street.

SOCIETY NOTES

The Connecticut State convention of the National Association of Stationary Engineers will be held in New Haven, June 24 and 25. The convention will be held in Engineer's hall, Bordman building. Space will be allotted for those desiring to exhibit steam specialties and power-plant appliances. The convention proper will be held in the same building.

The fifth annual convention of the International Association for the Prevention of Smoke will convene in the mayor's reception room, City Hall, Minneapolis, Minn., at 10 o'clock on the morning of Wednesday, June 29 next, and continue in session on June 30 and July 1. The headquarters will be Rogers hotel, which is convenient to the place of meeting.

The semi-annual meeting of the National Gas and Gasolene Engine Trades Association will be held at the Sinton hotel, Cincinnati, June 13 to 16, inclusive. The business program for the meeting will consist of a wide range of subjects from speakers of high standing in their various lines and among others may be mentioned the following: Carbureters, George M. Schebler; Ignition In Gas and Gasolene Engines, Carl Pfanstiehl; Gas Producers, L. F. Burger; Present and Future Opportunities in the South for the Gas Engine Builder, W. R. C. Smith; How to Illustrate and Describe Mechanical Installations, O. Monnett; Dry Batteries, H. S. Green; The Gas Engine Field in Mexico, G. W. Hall; Large Gas Engines, J. D. Lyon.

The regular spring meeting of the American Society of Mechanical Engineers will be held at Atlantic City, N. J., May 31 to June 3. The headquarters of the meeting will be the Marlborough-Blenheim hotel. Of the papers to be presented, those of interest to POWER readers are as follows: Improvements in Line Shaft Hangers and Bearings, by Henry Hess; Experimental Analysis of a Friction Clutch Coupling, by Prof. William T. Magruder; An Improved Absorption Dynamometer, by Prof. C. M. Garland; Critical Speed Calculations, by S. H. Weaver. The Gas Power Section lists the following papers: A Regenerator Cycle for Gas Engines Using Subadiabatic Expansion, by Prof. A. J. Frith; Gas Engines for Driving Alternating Current Generators, by H. G. Reist; Two Proposed Units of Power, by Prof. William T. Magruder; Some Operating Experiences with a Blast Furnace Gas Power Plant, by H. J. Freyn.

The program at the convention of the National District Heating Association to be held at Toledo, O., June 1, 2 and 3, includes papers as follows: Description of a Modern Central Hot-water Heating Station, by W. A. Wolls; Central Station Heating in Detroit, by A. D. Spencer; Humidity, Its Necessity and Benefits, by W. W. Brand; A Study on Insulation, by a representative of the Toledo Railway and Light Company; A Study in Centralizing the Heat Supply, by J. D. Hoffman;

Advantages to Be Derived from the Combination of Heating and Power, for the Central Station; The Profitable Operation of a Central Station without the Assistance of Electrical or Other Industries, by Bryan T. Gifford; The Factors that Enter into the Cost of Generating and Distributing Steam for Heating, by Charles B. Bishop; The Relative Efficiency and Resistance of Corrosion of Different Types of Radiators; Coal Production and Consumption, by R. H. Fernald.

NEW INVENTIONS

Printed copies of patents are furnished by the Patent Office at 5c each Address the Commissioner of Patents, Washington, D. C.

PRIME MOVERS

WAVE MOTOR. James M. Butler, Los Angeles, Cal., assignor of one-fourth to Joshua G. de Turk, Los Angeles, Cal. 956,796.

TWO-CYCLE INTERNAL-COMBUSTION ENGINE. Ernest A. Meyer, Freeport, Penn. 956,814.

GASOLENE ENGINE. John C. Bonnett, New Haven, Conn., assignor to Taylor, Stiles & Co., Riegelsville, N. J. 956,881.

INTERNAL-COMBUSTION ENGINE. Jas. H. Hopkins, Manchester, England. 956,967.

TWO-CYCLE ENGINE. Chas. B. Page, Baltimore, Md. 956,993.

GAS ENGINE. Louis C. Vanderlip, Elkhart, Ind. 957,017.

WATER WHEEL. Roy P. Robinson, Brilliant, Ohio. 957,099.

INTERNAL-COMBUSTION ENGINE TIMER. Joseph A. Schneider, Lakeport, Cal., assignor of two-thirds to Andrew A. Brown, San Francisco, Cal. 957,109.

STEAM TURBINE. Thomas Falvey, London, England. 957,151.

BOILERS, FURNACES AND GAS PRODUCERS

FURNACE GRATE. Thomas Dawson, Livingston Manor, N. Y. 956,517.

OIL BURNER. Harry M. Daggett, Oakland, Cal. 956,629.

CRUDE-OIL BURNER. Leon Fetty, Hutchinson, Kan. 956,695.

STOKING APPARATUS. George W. Bulley, New York, N. Y. 956,757.

AUTOMATIC WATER REGULATOR FOR GAS PRODUCERS. John P. Nawn, Philadelphia, Penn., assignor of one-half to George Schilling, Philadelphia, Penn. 956,818.

METHOD OF AND METHOD FOR PRODUCING GAS. Edwin E. Slick, Pittsburg, Penn. 957,006.

GAS PRODUCER. Edwin E. Slick, Pittsburg, Penn.. 957,007.

STEAM BOILER. William M. Gentle, Southport, Ind. 957,155.

FURNACE. Joseph W. Hays, Chicago, Ill., assignor to Carb-Ox Company, a Corporation of Illinois. 957,158.

STRAW-BURNING FURNACE. Andrew G. Johnson, Sutton, Neb. 957,163.

FUEL ECONOMIZER. Edwin R. Phillips, El Paso, Tex. 957,173.

POWER PLANT AUXILIARIES AND APPLIANCES

AUTOMATIC DAMPER CONTROL. Hjalmar Peterson, Falun, Wis. 956,542.

COMBINED AUTOMATIC THROTTLE AND STOP VALVE. Robert A. McKee, Milwaukee, Wis., assignor to Allis-Chalmers Company, Milwaukee, Wis., a Corporation of New Jersey. 956,595.

LEATHER CUP. Isaac H. Venn, Yonkers, N. Y., assignor to Otis Elevator Company, East Orange, N. J., a Corporation of New Jersey. 956,612.

STEAM-BOILER REGULATOR AND FEEDER. Victor Garbarino, Malden, Mass. 956,635.

ENGINE STARTER. Ephraim N. Rittase, Manchester, Md. 956,646.

FLUE CLEANER. Valentine G. Becker, St. Paul, Minn. 956,668.

FLUE BLOWER. George W. Bernauer, St. Charles, Mo. 956,670.

AUTOMATIC LUBRICATOR. Ferrand F. Ellis, Oneida, N. Y. 956,694.

GREASE CUP. Knut O. Dufva and Axel E. Dufva, St. Paul, Minn., assignors of one-third to Frederick Widmark, St. Paul, Minn. 956,761.

VALVE-OPERATING MECHANISM. Paul W. Knauf, Cynwyd, Penn., assignor to Schulte & Koerting Company, Philadelphia, Penn., a Corporation of Pennsylvania. 956,772.

ADJUSTABLE SPARK PLUG. Jefferson S. Palmer, Clark, S. D. 956,778.

TUBE CUTTER. Emanuel C. Heller and Artenaous J. Emrick, Germantown, Ohio, assignors of one-third to Willard Lincoln Hutchinson, Germantown, Ohio. 956,805.

VALVE. Frederick Leadbeater, Detroit, Mich. 956,811.

GAS-ENGINE STARTER. George C. Hicks, Jr., Connersville, Ind., assignor to the P. H. & F. M. Roots Company, Connersville, Ind. 956,852.

MUFFLER. Edward D. Sizer, Sizerville, Penn. 956,906.

RETURN-CHECK VALVE. John Collis, Newark, N. J. 956,944.

BOILER-TUBE SPREADER. John J. Maher, Philadelphia, Penn., assignor to the Babcock & Wilcox Company, Bayonne, N. J., a Corporation of New Jersey. 956,986.

LUBRICATING VALVE. Carl Senn, Oakland, and David C. Demarest, San Francisco, Cal. 957,003.

VALVE. James Stone, Cleveland, Ohio. 957,012.

STEAM-CONTROLLING DEVICE. Giuseppe Restucci, Naples, Italy. 957,097.

ELECTRICAL INVENTIONS AND APPLIANCES

ELECTRODE FOR ARC LAMPS. George M. Dyott, Pittsburg, Penn., assignor to Westinghouse Electric and Manufacturing Company, a Corporation of Pennsylvania. 956,519.

DYNAMO ELECTRIC MACHINE. Chas. A. Psilander and Thomas S. Scott, Pittsburg, Penn., assignors to the Westinghouse Electric and Manufacturing Company, a Corporation of Pennsylvania. 956,543.

COMBINED ELECTRIC ARC OR RESISTANCE AND INDUCTION FURNACE. James H. Reid, Newark, N. J. 956,544.

DYNAMO ELECTRIC MACHINE. Egbert M. Tingley, Pittsburg, Penn., assignor to Westinghouse Electric and Manufacturing Company, a Corporation of Pennsylvania. 956,549.

BRUSH HOLDER FOR DYNAMO ELECTRIC MACHINES. Carl B. Auel, Wilkinsburg, Penn., assignor to Westinghouse Electric and Manufacturing Company, a Corporation of Pennsylvania. 956,666.

ELECTRIC SWITCH. Joseph H. Champ and Theodore H. Schutt, Cleveland, Ohio, assignors to the Bishop & Babcock Company, Cleveland, Ohio, a Corporation of Ohio. 956,679.

ELECTRICAL MEASURING INSTRUMENT. Paul MacGahan, Wilkinsburg, assignor to Westinghouse Electric and Manufacturing Company, a Corporation of Pennsylvania. 956,714.

BRUSH HOLDER. Robert Siegfried, Pittsburg, Penn., assignor to Westinghouse Electric and Manufacturing Company, a Corporation of Pennsylvania. 956,739.

SINGLE-PHASE ALTERNATING-CURRENT MOTOR AND GENERATOR. Valere A. Fynn, London, England. 956,845.

PORTABLE ELECTRIC DRILL. William C. Hafemeister, Cleveland, Ohio, assignor by mesne assignments to the Van Dorn & Dutton Company, Cleveland, Ohio, a Corporation of Ohio. 956,849.

DYNAMO ELECTRIC MACHINE. Fred B. Howell, Schenectady, N. Y., assignor to General Electric Company, a Corporation of New York. 956,855.

ALTERNATING-CURRENT MOTOR. Valere A. Fynn, London, England. 956,893.

TELAUTOGRAPH INSTRUMENT. Alphonsus L. Golden, Oakland, Cal. 957,050.

ELECTRIC FURNACE. Hiram W. Hixon, Philadelphia, Penn. 957,058.

MEANS FOR COOLING DYNAMO ELECTRIC MACHINES. Herman Roos, Berlin, Germany, assignor to General Electric Company, a Corporation of New York. 957,102.

MEANS FOR COOLING DYNAMO ELECTRIC MACHINES. Herman Roos, Berlin, Germany, assignor to General Electric Company, a Corporation of New York. 957,103.

ENGINEERING SOCIETIES

AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Pres., George Westinghouse; sec., Calvin W. Rice, Engineering Societies building, 29 West 39th St., New York. Monthly meetings in New York City. Spring meeting at Atlantic City, May 31 to June 6.

NATIONAL ELECTRIC LIGHT ASSOCIATION

Pres., Frank W. Frueauff, Denver, Colo.; sec. and treas., Frank M. Tait. Association York. Next annual convention, St. Louis, Mo., May 23-28.

AMERICAN SOCIETY OF NAVAL ENGINEERS

Pres., Engineer-in-Chief Hutch I. Cone, U .S. N.; sec. and treas., Lieutenant Henry C. Dinger, U. S. N., Bureau of Steam Engineering, Navy Department, Washington, D. C.

AMERICAN BOILER MANUFACTURERS' ASSOCIATION

Pres., E. D. Meier, 11 Broadway, New York; sec., J. D. Farasey, cor. 37th St. and Erie Railway, Cleveland, O.

WESTERN SOCIETY OF ENGINEERS

Pres., J. W. Alvord; sec., J. H. Warder, 1735 Monadnock Block, Chicago, Ill.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA

Pres., E. K. Morse; sec., E. K. Hiles, Oliver building, Pittsburg, Penn. Meetings 1st and 3d Tuesdays.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

Pres., L. B. Stillwell; sec., Ralph W. Pope, 32 W. Thirty-ninth St., New York. Meetings monthly, excepting July and August.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.

Pres., Prof. J. D. Hoffman; sec., William M. Mackay, P. O. Box 1818, New York City. Next semi-annual meeting, St. Louis, Mo., June 30 and July 1, 1910.

NATIONAL ASSOCIATION OF STATIONARY ENGINEERS

Pres., William J. Reynolds, Hoboken, N. J.; sec., F. W. Raven, 325 Dearborn street, Chicago, Ill. Next convention, Rochester, N. Y., September, 1910.

UNIVERSAL CRAFTSMEN COUNCIL OF ENGINEERS

Grand Worthy Chief, W. S. Cadwell, Chicago, Ill.; sec., Thomas H. Jones, 244 Eighth street, N. E., Washington, D. C. Next convention, Buffalo, N. Y., August 2-5, 1910.

AMERICAN ORDER OF STEAM ENGINEERS

Supr. Chief Engr., Frederick Markoe, Philadelphia, Pa.; Supr. Cor. Engr., William S. Wetzler, 753 N. Forty-fourth St., Philadelphia, Pa. Next convention, Philadelphia, Pa., June 6-10, 1910.

NATIONAL MARINE ENGINEERS BENEFICIAL ASSOCIATIONS.

Pres., William F. Yates, New York, N. Y.; sec., George A. Grubb, 1040 Dakin street, Chicago, Ill. Next meeting, St. Louis, Mo., January 16-21, 1911.

OHIO SOCIETY OF MECHANICAL, ELECTRICAL AND STEAM ENGINEERS

Pres., O. F. Rabbe; sec. and treas., Prof. F. E. Sanborn, Ohio State University, Columbus, Ohio. Next meeting, Cincinnati, May 19 and 20, 1910.

INTERNATIONAL MASTER BOILER MAKERS' ASSOCIATION

Pres., A. E. Brown; sec., Harry D. Vaught, 95 Liberty street, New York. Next meeting at Niagara Falls, Canada, May 24-27, 1910.

INTERNATIONAL UNION OF STEAM ENGINEERS

Pres., Matt. Comerford; sec., Robert A. McKee, 606 Main St., Peoria, Ill. Next convention, Denver, Colo., September, 1910.

NATIONAL DISTRICT HEATING ASSOCIATION.

Pres., A. C. Rogers, Toledo, O.; sec. and treas., D. L. Gaskill, Greenville, O. Next annual meeting at Toledo, O., May, 1910.

Moments with the Ad. Editor

A department for subscribers edited by the advertising service department of Power and the Engineer.

We have had a good deal to say in this department about the *sanity* of present-day advertising writing as compared with the stuff that some of the old-timers were wont to foist on an open-mouthed, pop-eyed public.

Once in a while, though, some reincarnated spirit of the original Barnum is loosened upon the world and straightway rushes to its natural channel—printers' ink.

And this is the sort of "break" it delights in:

"Lend Here a Patient Hearing to the Unfolding of a Bargain Story That Will Go Resounding Down the Corridors of Time as the Most Sensational and Attractive Ever Provided the Purchasing Public—

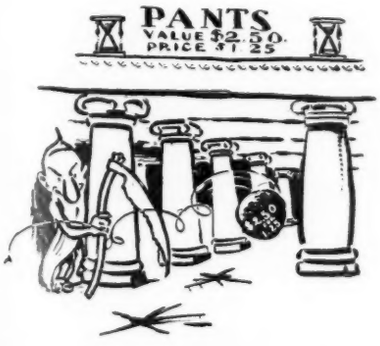
"Pants—Regular Value, $2.50—$1.25.

"Don't Overlook this Store on the Pants Question."

All that mass of words, covering six columns of newspaper space, about a pair of pants.

Doesn't that conjure up visions of the Tattooed Man, who never wears pants in exhibition, and the Bearded Lady, who always wears them when the show is over?

We have seen pants which look as though they might have resounded down several corridors of time.



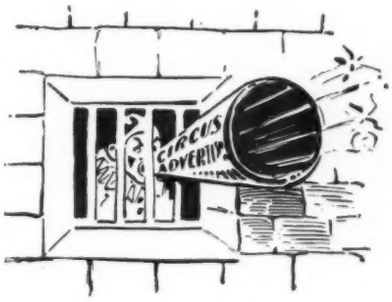
But they are not the kind of pants we choose to encase our shapely nether limbs in.

Rather are they the kind that we carefully avoid, lest their wearer make a touch for a new pair.

We have seen pants that one could buy for $1.25 a pair, but nothing could induce us to believe that they were worth $1.26, much less $2.50.

The quoted advertisement is fundamentally wrong in two points—it tells nothing about the advertised article and it leads the reader to infer that the concern is of a philanthropic nature—or is lying.

And, since we know that businesses exist on *profits*, we are prone to call them liars and shop at less superlative places.



Let us confine our exaggeration to circus advertising. None of us object to being beguiled into spending a dime for the side show. The "magnificent, marvelous, munificent, mind-maddening Albino Beauty" may be Maggie Hennessy, the waitress at Hyde's Hotel, done up in a frizzy wig—we don't care particularly. It's all in the day's fun.

But when we come down to the business side of things, let us cut out the Bombast, the "Break" and the Piffle. Let us have our advertisements clean-cut, informative, convincing and truthful.

We have a story to tell—tell it straight, tell it simply, tell it sincerely.

Then confidence is promoted and the shyster dethroned.

We believe that every advertiser in this paper makes a consistent effort to adhere to the straight line in writing his advertisements.

Hence, we know that they are full of *information*—dependable, instructive information.

The salesmen who call on you, the Selling Section of Power—here are two wonderfully rich mines of engineering knowledge. The pay streak runs wide and deep. Work it for all it's worth.

BUSINESS ITEMS

The Autoforce Ventilating System, of Boston, have opened an office in New York City, at 59 West Sixty-fifth street, in charge of E. J. Treat, ventilating engineer.

The Illinois Steel Company, one of the constituent companies of the United States Steel Corporation, has recently signed a contract with the Ball & Wood Company, for the installation of two 3000-kilowatt, Rateau-Smoot, mixed flow turbines, each to be directly connected to a 3000-kilowatt, 25-cycle, 2200-volt, 3-phase, alternating-current generator. These units are to be installed at the South Works, Chicago.

At the International Exposition at Brussels, Belgium, Chas. A. Schieren Company has an exhibition of eight running belt drives, all of them being hard and peculiar drives; one illustrates the Duxbak waterproof leather belt running and being continually sprayed with water. After the close of this exposition the exhibit will be moved to Turin where another international industrial exposition will be held next Spring.

The Power Specialty Company report that the volume of Foster superheater sales is increasing rapidly, the contracts secured so far this year nearly equaling the total of last year's business. The Chicago office of this company has been removed from the Rookery to the Peoples Gas building, where increased accommodations have been secured. This office is in charge of R. B. Nutting, manager, and R. H. Wyld, assistant manager.

Taking advantage of the opportunity offered by the low-pressure steam turbine when used in connection with the exhaust of other prime movers, for increasing plant output without requiring additional boiler capacity, the Baldwin Locomotive Company is installing three 500-kilowatt low-pressure units at its Philadelphia works. These turbines will utilize the exhaust steam from Westinghouse compound reciprocating engines already installed in the large power plant of these shops, making available a considerable additional amount of power, and effecting marked economical improvement in operation of this station. The increasing shop demands on the power house, following the return of the business tide, required this additional power equipment, and in making extensions along these lines, sacrifice of the existing steam-generating apparatus, which is in good condition, has been avoided.

NEW EQUIPMENT

A waterworks system is to be installed at Breaux Bridge, La.

The Fond du Lac (Wis.) Cold Storage Company will erect a three-story addition.

The Marshfield (Wis.) Brewery Company expect to install electric power in the near future.

The R. Starkweather Company, of Oshkosh, Wis., is in the market for a second-hand Corliss engine.

The Equitable Pottery Company, Trenton, N. J., is to increase the capacity of its power plant.

The Lyons Boiler Works, De Pere, Wis., is planning the erection of a new 300-horsepower plant.

Hugh G. Twaddle, of Hecla, S. D., is considering the erection of an electric-light plant at Baker, Mont.

The Central Massachusetts Electric Company, Palmer, Mass., is to make some additions to its plant.

The city of New Orleans, La., will issue $7,000,000 bonds for addition to waterworks, drainage, and sewage systems.

Additional boiler, engine and generator will be installed in the municipal electric-light and water plant at Alexandria, La.

The Spencer (Iowa) Light and Water Works is planning to install a new engine and boiler some time during the summer.

The Deckman-Duty Brick Company, Collinwood, Cleveland, Ohio, is in the market for smoke consumer, steam jet and air type.

The Ames Gas Company, Ames, Iowa, has been incorporated with $50,000 capital, and will erect a plant at once. H. L. Griffin is secretary.

Proposals will be received until 3 p.m., June 3, at the office of the constructing quartermaster, Fort Des Moines, Iowa, for the installation of a steam-heating plant in hospital.

The Gage County Gas, Light and Power Company, it is said, will build a $90,000 plant at Beatrice, Neb. Plant will be run by water power, but is to be equipped also with gas engines.

Sealed proposals will be received at the office of constructing quartermaster, Whipple Barracks, Ariz., until 3 p.m., May 31, for the construction of an ice plant. Information can be had of Second Lieutenant G. G. Bartlett, constructing quartermaster.

Bids will be received at the office of the constructing quartermaster, 655 Congress street, Portland, Me., until 10 a.m., June 2, for constructing and remodeling electric-light system, at Fort McKinley, Me. Information can be had of Capt. E. F. Humphrey.

Sealed proposals will be received by the constructing quartermaster, Fort Bayard, N. M., until 11 a.m., May 28, for furnishing and installing machinery for power, refrigerating and electric-lighting systems. Information can be had of First-Lieutenant Chas. C. Winnia.

Bids will be received by P. E. Ryan, secretary, National Transcontinental Railway Commissioners, Ottawa, Canada, until 12 o'clock noon, May 25, for necessary equipment for power house to be erected near Winnipeg, including boilers, heaters, stokers, pumps, engines, generators, etc.

Proposals will be received at the office of supervising architect, Treasury Department, Washington, D. C., until 3 p.m., June 15, for the installation of heating plant, pumps, vacuum-cleaning plant, electric wiring, etc., for the United States custom house and appraisers' stores building, at San Francisco. Information can be had of James Knox Taylor, supervising architect.

Proposals will be received at the office of supervising architect, Treasury Department, Washington, D. C., up to 3 p.m., June 13, for the installation of a new high-pressure steam-boiler plant and accessories for the United States Court House and Post Office building, Pittsburg, Penn. Information can be had of James Knox Taylor, supervising architect.

The Navy Department, Bureau of Supplies and Accounts, Washington, D. C., will open bids May 31, for 2300 water-gage glasses (schedule 2510), two 10-horsepower electric motors, four induction motors (schedule 2506), hoisting engine and boiler (schedule 2495); June 7—Two 2- and 3-horsepower motors (schedule 2518); June 14—One hundred and three brass gate valves, 501 brass and globe angle valves (schedule 2517), 3000 gallons gas-engine cylinder oil (schedule 2514), 315,000 gallons fuel oil (schedule 2515), 294,000 gallons fuel oil (schedule 2514).

NEW CATALOGS

Norman C. Hayner Company, Rochester, N. Y. Folder. Powder boiler compound.

Fort Wayne Electric Works, Fort Wayne, Ind. Booklet 5022. Fan motors. Illustrated, 32 pages, 3½x6 inches.

General Electric Company, Schenectady, N. Y. Bulletin No. 4719. Fan motors. Illustrated, 36 pages, 8x10½ inches.

Lackawanna Grate Bar Company, Scranton, Penn. Catalog. Lackawanna grates and blowers. Illustrated, 5½x8 inches.

American Blower Company, Detroit, Mich. Booklet No. 269. Electric fan and air purifier. Illustrated, 30 pages, 4½x6 inches.

C. H. Wheeler Manufacturing Company, Philadelphia, Penn. Bulletin No. 12. Condensers. Illustrated, 36 pages, 3½x6 inches.

Detroit Lubricator Company, Detroit, Mich. Catalog. Sight feed and plain cylinder lubricators. Illustrated, 14 pages, 3½x6 inches.

Graphoil-Lubricator Sales Company, 90 West street, New York. Catalog. Graphoil lubricating specialties. Illustrated, 16 pages, 3½x8 inches.

The Schaeffer & Budenberg Manufacturing Company, Brooklyn, N. Y. Catalog. Pressure and vacuum gages. Illustrated, 48 pages, 7x10½ inches.

Geo. J. Hagan, Peoples Bank building, Pittsburg, Penn. Catalog. Bailey combination sheet and pair furnace. Illustrated, 16 pages, 6x9 inches.

HELP WANTED

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

WANTED—Thoroughly competent steam specialty salesman; one that can sell high-grade goods. Address "M. M. Co.," POWER.

AN ENGINEER in each town to sell the best rocking grate for steam boilers. Write Martin Grate Co., 281 Dearborn street, Chicago.

WANTED—A first-class feed water heater salesman for western Pennsylvania, West Virginia and Ohio; a salaried position; reference required. Box 185, POWER.

SALESMEN calling on power plant trade to handle an economic, easily sold specialty on a most profitable basis. Address Graphoil Lubricator Sales Co., 90 West St., New York.

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Advertisements under this head are inserted for 25 cents per line. About six words make a line.

MECHANICAL ENGINEER desires to correspond with some firm or corporation that needs the services of a capable and confidential man who can earn a salary of $5000 to $10,000 per year; experienced as sales manager, general manager of business, cost accountant and general expert accounting work, and traveling salesman, in addition to detail shop experience, handling of men, designing, erecting and general consulting work; would consider $5000 per year at start. Address Box 183, POWER.

SITUATION WANTED by engineering graduate with construction or manufacturing company, at present am chief engineer of power station in Massachusetts; previous work chiefly in connection with steam turbines. Address Box 187, POWER.

TECHNICAL GRADUATE, age 33, desires engagement; wide experience as sales engineer and office manager; extensive acquaintance; references unexcelled. Box 155, POWER.

CHIEF ENGINEER wants position; first-